NELLCOR PURITAN BENNETT

SERVICE MANUAL

Nellcor Symphony®
N-3000 Patient Monitor
SpO2, ECG, and Respiration Capabilities

To contact Nellcor Puritan Bennett's representative: *In the United States, call 1-800-NELLCOR or 510 463-4000; outside the United States, call your local Nellcor Puritan Bennett representative.*

Caution: Federal law (U.S.) restricts this device to sale by or on the order of a physician.

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Corporate Headquarters

Nellcor Puritan Bennett Inc.
4280 Hacienda Drive
Pleasanton, California 94588 U.S.A.
Tel. 510 463-4000 or
1-800-NELLCOR
Fax 510 463-4420

U.S. Service Repair Center

Nellcor Puritan Bennett Inc.
2391 Fenton Street
Chula Vista, California 91914
U.S.A.
Tel. 619 482-5000

European Office

Nellcor Puritan Bennett Europe BV
Hambakenwetering 1
5231 DD 's-Hertogenbosch
The Netherlands
Tel. +31.73.6485200

Asia/Pacific Office

Nellcor Puritan Bennett HK Ltd.
Room 1602 Evergo House
38 Gloucester Road
Wanchai
Hong Kong
Tel. +852.2529.0363

Regional/Local Offices

Nellcor Puritan Bennett UK Ltd.
10, Talisman Business Centre
London Road
Bicester
Oxfordshire OX6 0JX
United Kingdom
Tel. +44.1869.322700

Nellcor Puritan Bennett Belgium NV/SA
Interleuvenlaan 62/8, Zone 2
B-3001 Heverlee
Belgium
Tel. +32.16.400467

Nellcor Puritan Bennett France
21 rue Albert Calmette
78353 Jouy-en-Josas Cedex
France
Tel. +33.1.34.63.06.00

Nellcor Puritan Bennett Germany GmbH
Black-&-Decker-Strasse 28
65510 Idstein
Germany
Tel. +49.6126.5930

Nellcor Puritan Bennett Italia Srl
Via dei Tulipani, 3
20090 Pieve Emanuele (MI)
Italy
Tel. +39.2.90786404

To obtain information about a warranty, if any, for this product, contact Nellcor Puritan Bennett Technical Services or your local Nellcor Puritan Bennett representative.

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SECTION 1: INTRODUCTION

1.1 Manual Overview
1.2 N-3000 Patient Monitor Description
1.3 Related Documents

1.1 MANUAL OVERVIEW

This manual contains information for servicing the *Nellcor Symphony* model N-3000 patient monitor. Only qualified service personnel should service this product. Before servicing the N-3000, read the operator's manual carefully for a thorough understanding of operation.

1.2 N-3000 PATIENT MONITOR DESCRIPTION

The purpose and function of the *Nellcor Symphony* N-3000 patient monitor is to noninvasively and continuously monitor functional arterial oxygen saturation, ECG, pulse rate, heart rate, and respiration rate for adult, pediatric, and neonatal patients in all hospital areas and hospital-type facilities. It may be used for hospital transport when powered by its internal battery.

The N-3000 can operate as a standalone monitor or it can be connected to (stacked with) other *Nellcor Symphony* instruments, such as the N-3100 blood pressure monitor and N-3200 display/printer. When used with the N-3200 display/printer, the instruments can display and print out ECG, respiration, and plethysmographic waveforms and SpO_2, pulse rate, heart rate, and respiration rate tabular data.

The physical and operational characteristics of the monitor are described in the operator's manual and Section 9, *Specifications*, of this manual.

Figure 1-1 depicts the front panel of the N-3000 and the names of its displays and controls.

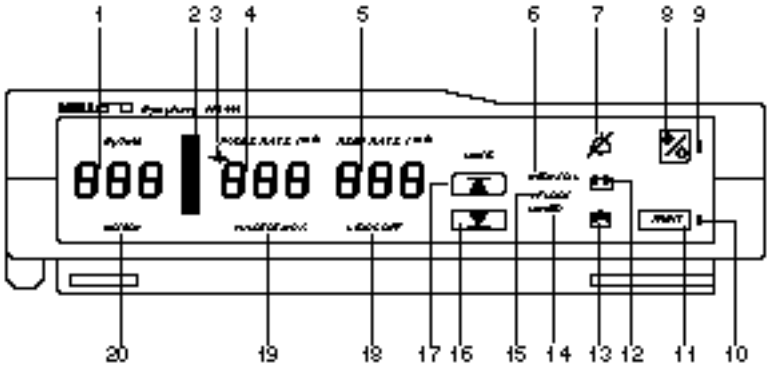


Figure 1-1: N-3000 Front Panel

1. SpO_2% display
2. PULSE AMPLITUDE indicator
3. ECG HEART RATE indicator
4. HEART/PULSE RATE display
5. RESPIRATION RATE display
6. NEONATAL MODE indicator
7. AUDIBLE ALARM OFF indicator
8. ON/STANDBY button
9. POWER ON indicator
10. STACKED indicator
11. PRINT button
12. BATTERY IN USE/BATTERY LOW indicator
13. BATTERY CHARGING indicator
14. LINKED indicator*
15. RF LOCKED indicator*
16. LOWER ALARM LIMIT button
17. UPPER ALARM LIMIT button
18. LEADS OFF indicator
19. PULSE SEARCH indicator
20. PATIENT MOTION indicator

* Not used on this model

1.3 RELATED DOCUMENTS

To perform test and troubleshooting procedures and to understand the principles of operation and circuit analysis sections of this manual, you must know how to operate the monitor. Refer to the N-3000 operator's manual. To understand the various *Nellcor Puritan Bennett* sensors and ECG leads that work with the monitor, refer to the individual sensor or leads directions for use.

SECTION 2: ROUTINE MAINTENANCE

2.1 Cleaning
2.2 Periodic Safety and Functional Checks
2.3 Batteries

2.1 CLEANING

Caution: Do not immerse the N-3000 or its accessories in liquid or clean with caustic or abrasive cleaners. Do not spray or pour any liquid on the monitor or its accessories.

To clean the N-3000, dampen a cloth with a commercial, nonabrasive cleaner and wipe the exterior surfaces lightly. Do not allow any liquids to come in contact with the power connector, fuse holder, or switches. Do not allow any liquids to penetrate connectors or openings in the instrument cover. Wipe sensor and ECG lead extension cables with a damp cloth. For sensors and ECG leads, follow the individual directions for use.

2.2 PERIODIC SAFETY AND FUNCTIONAL CHECKS

The following checks should be performed at least every 2 years by a qualified service technician.

1. Inspect the exterior of the N-3000 for damage.

2. Inspect safety labels for legibility. If the labels are not legible, contact Nellcor Puritan Bennett's Technical Services Department or your local Nellcor Puritan Bennett representative.

3. Verify that the unit performs properly as described in paragraph 3.3.

4. Perform the electrical safety tests detailed in paragraph 3.4. If the unit fails these electrical safety tests, do not attempt to repair. Contact Nellcor Puritan Bennett's Technical Services Department or your local Nellcor Puritan Bennett representative.

5. Inspect the fuses for proper value and rating (F1: 1.0 Amp, 250 Volt, Slo-Blow and F2: 2.5 Amp, 250 Volt, Slo-Blow) as discussed in paragraph 6.4.

2.3 BATTERIES

Nellcor Puritan Bennett recommends replacing instrument batteries at least every 2 years. To replace the batteries, refer to Section 6, *Disassembly Guide*.

If the N-3000 has been stored for more than 30 days, charge the battery as described in paragraph 3.3.1. A fully discharged battery requires 14 hours of charging time for a full charge. A 6-hour charge is required for 1 hour of operating time.

SECTION 3: PERFORMANCE VERIFICATION

3.1 Introduction
3.2 Equipment Needed
3.3 Performance Tests
3.4 Safety Tests

3.1 INTRODUCTION

This section discusses the tests used to verify performance following repairs or during routine maintenance. All tests can be performed without removing the N-3000 cover. All tests except the battery charge and battery performance tests must be performed as the last operation before the monitor is returned to the user.

If the N-3000 fails to perform as specified in any test, repairs must correct the problem before the monitor is returned to the user.

3.2 EQUIPMENT NEEDED

Equipment	**Description**
AC power adapter	Use an appropriate *Nellcor Symphony* SPS-N1 or PSS-1 power supply.
Connector adapter	6-pin, “D”
Digital multimeter (DMM)	Fluke Model 87 or equivalent
Durasensor® oxygen transducer	DS-100A
ECG cable	SCE-10
ECG electrodes	standard
ECG leads	SLE series
ECG simulator	Dynatech Nevada, medSim 300 or equivalent
Oxisensor® *II* oxygen transducer	D-25
Pulse oximeter tester	SRC-2
Respiration simulator	Dynatech Nevada, medSim 300 or equivalent
Safety analyzer	Must meet current AAMI specifications
Sensor cable	SCP-10
Serial interface cable	EIA-232 cable (optional)
Stopwatch	Manual or electronic

3.3 PERFORMANCE TESTS

The battery charge procedure should be performed before monitor repairs whenever possible. It should also be performed before and after performing the battery performance test (paragraph 3.3.2).

This section is written using Nellcor Puritan Bennett factory-set defaults. If your institution has preconfigured custom defaults, those values will be displayed. Factory defaults can be reset using the configuration mode procedure described in paragraph 4.2.10.6.

3.3.1 Battery Charge

Perform the following procedure to fully charge the battery.

1. Connect the monitor to an AC power source using an external power supply.

2. Verify that the monitor is off and that the BATTERY CHARGING indicator is lit.

3. Charge the battery for at least 14 hours.

   Note: The BATTERY CHARGING indicator is programmed to go out when the N-3000 has been connected to AC power for approximately 14 hours with no power interruptions. If there are any power interruptions, the 14-hour charging period begins again when power is restored.

   An illuminated BATTERY CHARGING indicator is not necessarily an indication that the battery contains less than a full charge. It is merely used as a timer to indicate that the battery has been continuously charging for less than 14 hours.

4. The only way to check for a full charge is to perform the procedure in paragraph 3.3.2 “Battery Performance Test.”

3.3.2 Battery Performance Test

The monitor is specified to operate on battery power a minimum of 4 hours. (This time may decrease if the N-3000 is operating in the stacked configuration with an N-3100 or N-3200.) Before performing this test, ensure that the battery is fully charged (paragraph 3.3.1).

1. Connect the *Nellcor Puritan Bennett* SRC-2 pulse oximeter tester to the monitor via the SCP-10 sensor cable.

2. Set the SRC-2 switches as follows:

SWITCH	**POSITION**
RATE	38
LIGHT	LOW
MODULATION	LOW
RCAL/MODE	RCAL 63/LOC

3. Ensure that the monitor is not connected to AC power.

4. With the N-3000 turned off, press the ON/STANDBY button and verify that the BATTERY IN USE/BATTERY LOW indicator lights after the power-on self-test is completed. Verify that the monitor is responding to the simulator signal and the audible alarm is sounding. Do not silence the alarm during this test.

5. The monitor must operate for at least 4 hours.

6. Verify that the BATTERY IN USE/BATTERY LOW indicator will start to flash after about 3.5 to 3.75 hours (15-30 minutes before the battery fully discharges).

7. Allow the monitor to operate until it automatically powers down due to the low battery.

8. If the monitor passes this test, immediately recharge the battery (paragraph 3.3.1, steps 1 - 3).

3.3.3 Power-up Performance

The power-up performance tests (3.3.3.1 through 3.3.3.3) verify the following monitor functions:

- 3.3.3.1 Power-On Self-Test
- 3.3.3.2 Adult Defaults and Alarm Limit Ranges
- 3.3.3.3 Neonate Defaults and Alarm Limit Ranges

3.3.3.1 Power-On Self-Test

1. Connect the monitor to an AC power source and verify that the BATTERY CHARGING indicator is lit.

2. Do not connect any input cables to the monitor.

3. Observe the monitor front panel. With the monitor off, press the ON/STANDBY button. The monitor must perform the following sequence.

   a. The monitor emits three consecutively higher pitched beeps.

   b. All indicators light for a few seconds as illustrated in Figure 3-1. Verify that the SpO_2% (left-most display), HEART/PULSE RATE (middle), and RESPIRATION RATE (right) displays all indicate “8.8.8.”.

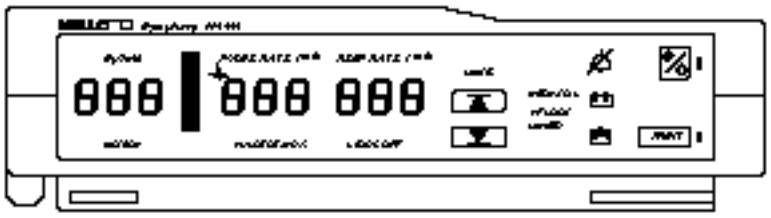


Figure 3-1: Self-Test Display

   c. All displays turn off momentarily.

d. Digital displays individually light in a scanning test pattern.

e. A 1-second beep sounds and all displays again illuminate momentarily.

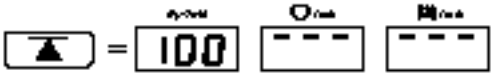
f. All displays turn off except the POWER ON and BATTERY CHARGING indicators. The SpO_2% and HEART/PULSE RATE displays are blank. The RESPIRATION RATE display indicates “0” for about 15 seconds, then is blank. The monitor is in the “normal mode steady state.”

g. Press and hold the NEW PATIENT/NEONATAL button (located on the rear panel) for 3 seconds until you hear three beeps, indicating that stored patient data is cleared.

3.3.3.2 Adult Power-On Defaults and Alarm Limit Ranges

Note: When observing or changing default limits, a 3-second timeout is in effect, that is, if no action is taken within 3 seconds, the monitor automatically returns to the normal mode steady state.

1. Ensure that the monitor is on. Press and release the UPPER ALARM LIMIT button. Verify that the monitor emits a single beep and the SpO_2% display indicates an alarm limit of “100” for about 3 seconds. Verify that the other displays indicate a single bar at the top of each window while the “100” is displayed.



   At the end of the 3 seconds, the displays are blank (normal mode steady state).

2. Press and release the UPPER ALARM LIMIT button. Begin rotating the control knob counterclockwise (CCW) within 3 seconds. Verify that the SpO_2% display reduces to a minimum of “85.”.

   Note: A decimal point in the display indicates that the alarm limits have changed.

3. Press and release the LOWER ALARM LIMIT button. Verify that the monitor emits a single beep and the SpO_2% display indicates an alarm limit of “85” for 3 seconds. Verify that the other displays indicate a single bar at the bottom of each window.

4. Press and hold the LOWER ALARM LIMIT button. Rotate the control knob CCW and verify that the SpO_2% display reduces to a minimum of “20”. Rotate the control knob clockwise (CW) and verify that the SpO_2% display cannot be raised past the upper alarm limit setting of “85”.

5. Press the UPPER ALARM LIMIT button two times rapidly (twice within 3 seconds). Verify that the monitor emits two beeps and the HEART/PULSE RATE display indicates an alarm limit of “170” for about 3 seconds.

6. From the normal mode steady state, press the UPPER ALARM LIMIT button two times rapidly. Begin rotating the control knob CCW within 3 seconds. Verify that the HEART/PULSE RATE display reduces to a minimum of “40”.

7. Press the LOWER ALARM LIMIT button two times rapidly. Verify that the HEART/PULSE RATE display indicates an alarm limit of “40” for 3 seconds.

8. From the normal mode steady state, press the LOWER ALARM LIMIT button two times rapidly. Rotate the control knob CCW. Verify that the HEART/PULSE RATE display reduces to a minimum of “30”.

9. Press the LOWER ALARM LIMIT button three times rapidly. Verify that the RESPIRATION RATE display indicates an alarm limit of “4” for 3 seconds.

10. From the normal mode steady state, press the LOWER ALARM LIMIT button three times rapidly. Begin rotating the control knob CW within 3 seconds. Verify the RESPIRATION RATE display increases to a maximum of “40”.

11. Press the UPPER ALARM LIMIT button three times rapidly. Verify the RESPIRATION RATE display indicates an alarm limit of “40” for 3 seconds.

12. Press the UPPER ALARM LIMIT button three times rapidly. Begin rotating the control knob CW within 3 seconds. Verify that the RESPIRATION RATE display increases to a maximum of “150”.

13. Press the ON/STANDBY button to turn the monitor off. Verify that the monitor emits three decreasing pitch beeps.

14. Press the ON/STANDBY button to turn the N-3000 back on.

15. Press and release the UPPER ALARM LIMIT button. Verify that the SpO_2% display indicates an alarm limit of “100”.

16. Press and release the LOWER ALARM LIMIT button. Verify that the SpO_2% display indicates an alarm limit of “85”.

17. Press the UPPER ALARM LIMIT button two times rapidly. Verify that the HEART/PULSE RATE display indicates an alarm limit of “170”.

18. Press the LOWER ALARM LIMIT button two times rapidly. Verify that the HEART/PULSE RATE display indicates an alarm limit of “40”.

19. Press the UPPER ALARM LIMIT button three times rapidly. Verify that the RESPIRATION RATE display indicates an alarm limit of “40”.

20. Press the LOWER ALARM LIMIT button three times rapidly. Verify that the RESPIRATION RATE display indicates an alarm limit of “4”.

21. Press the ON/STANDBY button to turn the monitor off.

3.3.3.3 Neonate Power-On Defaults and Alarm Limit Ranges

Note: When observing or changing default limits, a 3-second timeout is in effect, that is, if no action is taken within 3 seconds, the monitor automatically returns to the normal mode steady state.

1. Turn the monitor on.

2. Press the NEW PATIENT/NEONATAL button on the rear panel twice within 2 seconds. Verify that there is an audible beep each time the button is pressed.

3. Verify that the NEONATAL MODE indicator on the front panel is lit.

4. Press and release the UPPER ALARM LIMIT button. Verify that the SpO_2% display indicates an alarm limit of “95” for 3 seconds. Verify that the other displays indicate a single bar at the top of each window while the “95” is displayed.

5. Press and release the UPPER ALARM LIMIT button. Begin rotating the control knob CCW within 3 seconds. Verify that the SpO_2% display reduces to a minimum of “80”.

6. Press and release the LOWER ALARM LIMIT button. Verify that the SpO_2% display indicates an alarm limit of “80”. Verify that the other displays indicate a single bar at the bottom of each window.

7. From the normal mode steady state, press and release the LOWER ALARM LIMIT button. Rotate the control knob CCW. Verify that the SpO_2% display reduces to a minimum of “20”.

8. Press the UPPER ALARM LIMIT button two times rapidly (twice within 3 seconds). Verify that the HEART/PULSE RATE display indicates an alarm limit of “190”.

9. Press the LOWER ALARM LIMIT button twice rapidly. Verify that the HEART/PULSE RATE display indicates an alarm limit of “90”.

10. Press the UPPER ALARM LIMIT button three times rapidly. Verify that the RESPIRATION RATE display indicates an alarm limit of “80”.

11. Press the LOWER ALARM LIMIT button three times rapidly. Verify that the RESPIRATION RATE display indicates an alarm limit of “20”.

12. Press the ON/STANDBY button to turn the monitor off.

13. Press the ON/STANDBY button to turn the monitor on. The monitor performs the sequence described in 3.3.3.1. Verify that the “NEO” indicator is *not* lit.

14. Press and release the UPPER ALARM LIMIT button. Verify that the SpO_2% display indicates an alarm limit of “100”.

15. Press and release the LOWER ALARM LIMIT button. Verify that the SpO_2% display indicates an alarm limit of “85”.

16. Press the ON/STANDBY button to turn the monitor off.

This completes the power-up performance tests.

3.3.4 Hardware and Software Tests

Hardware and software testing include the following tests.

- 3.3.4.1 Operation with a Pulse Oximeter Tester
- 3.3.4.2 Operation with an ECG Simulator
- 3.3.4.3 Operation with a Respiration Simulator
- 3.3.4.4 General Operation

3.3.4.1 Operation with a Pulse Oximeter Tester

Operation with an SRC-2 pulse oximeter tester includes the following tests.

- 3.3.4.1.1 Alarms and Alarm Silence
- 3.3.4.1.2 Alarm Volume Control
- 3.3.4.1.3 Pulse Tone Volume Control
- 3.3.4.1.4 Dynamic Operating Range
- 3.3.4.1.5 RCAL Determination
- 3.3.4.1.6 LED Drive Test

3.3.4.1.1 Alarms and Alarm Silence

1. Connect the SRC-2 pulse oximeter tester to the sensor input cable and connect the cable to the monitor. Set the SRC-2 as follows:

SWITCH	**POSITION**
RATE	38
LIGHT	LOW
MODULATION	OFF
RCAL/MODE	RCAL 63/LOCAL

2. Press the ON/STANDBY button to turn the monitor on. After the normal power-up sequence, verify that the SpO_2%, HEART/PULSE RATE and RESPIRATION RATE displays initially indicate zeroes.

   Note: The pulse bar may occasionally indicate a step change as the monitor is in the pulse search mode.

3. Move the modulation switch on the SRC-2 to LOW.

4. Verify that the following monitor reaction:

   a. The pulse bar begins to track the artificial pulse signal from the SRC-2.

   b. The pulse tone is heard.

   c. Zeroes are displayed in the SpO_2%, HEART/PULSE RATE, and RESPIRATION RATE displays.

   d. After about 10 to 20 seconds, the monitor displays a saturation and pulse rate as specified by the tester. Verify that the values are within the following tolerances:

      Oxygen Saturation Range 79% to 83%
      Pulse Rate Range 37 to 39 bpm

e. The audible alarm sounds and both the SpO_2% and HEART/PULSE RATE displays will flash, indicating both parameters have violated the default alarm limits.

5. Press and momentarily hold the AUDIBLE ALARM OFF button on the top of the monitor. Verify that the HEART/PULSE RATE display indicates “60” and the RESPIRATION RATE display indicates “SEC” while the AUDIBLE ALARM OFF button is pressed. The alarm is silenced.

6. Release the AUDIBLE ALARM OFF button. Verify the following:

   a. The alarm remains silenced.

   b. The AUDIBLE ALARM OFF indicator lights.

   c. The SpO_2% and HEART/PULSE RATE displays resume flashing.

   d. The pulse tone is still audible.

   e. The audible alarm returns in approximately 60 seconds.

7. Press and hold the AUDIBLE ALARM OFF button. Rotate the control knob CCW until the HEART/PULSE RATE display indicates “30”. Rotate the control knob CW and verify that the displays indicate 60 SEC, 90 SEC, 120 SEC, and OFF. Release the button when the display indicates “OFF”. Verify that the AUDIBLE ALARM OFF indicator flashes.

8. Wait approximately 3 minutes. Verify that the alarm does not return. After 3 minutes, the alarm silence reminder beeps three times, and will continue to do so at 3-minute intervals.

3.3.4.1.2 Alarm Volume Control

After completing the procedure in paragraph 3.3.4.1.1:

1. Press and hold the AUDIBLE ALARM OFF button on the top of the monitor. Verify the following:

   a. “OFF” is displayed for approximately 3 seconds.

   b. After 3 seconds, a steady tone is heard at the default alarm volume setting, the HEART/PULSE RATE display indicates “VOL”, and the RESPIRATION RATE display indicates the default setting of 5.

2. While continuing to hold the AUDIBLE ALARM OFF button, rotate the control knob CCW to decrease the alarm volume setting to a minimum value of 1. The alarm tone should decrease but still be audible.

3. Rotate the control knob CW to increase the alarm volume setting to a maximum value of 10. Verify the volume increases. Rotate the knob CCW until a comfortable audio level is attained.

4. Release the AUDIBLE ALARM OFF button. The tone will stop.

3.3.4.1.3 Pulse Tone Volume Control

1. Rotate the control knob CW and verify that the beeping pulse tone sound level increases.

2. Rotate the control knob CCW and verify that the beeping pulse tone decreases until it is no longer audible. Rotate the knob CW to return the beep volume to a comfortable level.

3.3.4.1.4 Dynamic Operating Range

The following test sequence verifies proper monitor operation over a range of input signals.

1. Connect the SRC-2 to the N-3000 and turn the N-3000 on.

2. Place the SRC-2 in the RCAL 63/LOCAL mode.

3. Set the SRC-2 as indicated in Table 3-1. Verify that the N-3000 readings are within the indicated tolerances. Allow the monitor several seconds to stabilize the readings.

Note: A "*" indicates values that produce an alarm. Press the AUDIBLE ALARM OFF button to silence the alarm.

Table 3-1: Dynamic Operating Range

SRC-2 Settings			N-3000 Indications	
RATE	**LIGHT**	**MODULATION**	**SpO_2**	**Pulse Rate**
38	HIGH2	LOW	79 - 83*	37 - 39*
112	HIGH1	HIGH	79 - 83*	110 - 114
201	LOW	LOW	79 - 83*	195 - 207*
201	LOW	HIGH	79 - 83*	195 - 207*

4. Turn the monitor off.

3.3.4.1.5 RCAL Determination

1. Ensure that the N-3000 is turned off and connected to AC power via an external power supply.

2. Connect the SRC-2 pulse oximeter tester to the sensor input cable and connect the cable to the monitor. Set the SRC-2 as follows:

SWITCH	**POSITION**
RATE	38
LIGHT	LOW
MODULATION	OFF
RCAL/MODE	RCAL 63/LOCAL

3. Enter the service mode as follows:

   a. While simultaneously holding down the UPPER and LOWER ALARM LIMIT buttons and the PRINT button, press and release the ON/STANDBY button. Continue to press and hold the UPPER and LOWER ALARM LIMIT and PRINT buttons while the monitor performs the power-on test.

   b. When "SEr" begins flashing in the AUXILIARY display, release the UPPER and LOWER ALARM LIMIT and PRINT buttons.

c. Press the PRINT button within 15 seconds or the monitor will turn off automatically. The number “1” appears in the SpO_2% display. You are now in the service mode steady state.

4. Select menu item 30 by rotating the knob until “30” appears in the SpO_2% display.

5. Press the UPPER ALARM LIMIT button.

6. Verify the RCAL index number “63” is displayed in the HEART/PULSE RATE display.

7. Set the SRC-2 RCAL/Mode switch to 64/LOCAL and verify that “64” is displayed in the HEART/PULSE RATE display.

8. Press the ON/STANDBY button to turn the monitor off.

3.3.4.1.6 LED Drive Test

1. Ensure that the N-3000 is turned off and connected to AC power via an external power supply.

2. Connect the SRC-2 pulse oximeter tester to the sensor input cable and connect the cable to the monitor. Set the SRC-2 as follows:

SWITCH	**POSITION**
RATE	38
LIGHT	LOW
MODULATION	OFF
RCAL/MODE	RCAL 63/LOCAL

3. Enter the service mode as follows:

   a. While simultaneously holding down the UPPER and LOWER ALARM LIMIT buttons and the PRINT button, press and release the ON/STANDBY button. Continue to press and hold the UPPER and LOWER ALARM LIMIT and PRINT buttons while the monitor performs the power-on test.

   b. When “SEr” begins flashing in the AUXILIARY display, release the UPPER and LOWER ALARM LIMIT and PRINT buttons.

   c. Press the PRINT button within 15 seconds or the monitor will turn off automatically. The number “1” appears in the SpO_2% display. You are now in the service mode.

4. Select menu item 33 by rotating the knob until “33” appears in the SpO_2% display.

5. Press the UPPER ALARM LIMIT button.

6. Verify that the SpO_2 IR LED drive value “170” is displayed in the HEART/PULSE RATE display and the IR indicator on the SRC-2 is illuminated.

7. Rotate the control knob to adjust the IR LED drive level indicated in the HEART/PULSE RATE display to “255”.

8. While watching the IR indicator on the SRC-2, press the UPPER ALARM LIMIT button and verify that the LED intensity increases.

9. Rotate the knob to adjust the IR LED drive level to “0”.

10. Press the UPPER ALARM LIMIT button. Verify that the IR LED turns off.

11. Rotate the knob to adjust the IR LED drive level to “170”.

12. Press the UPPER ALARM LIMIT button and verify that the LED intensity increases.

13. Press the LOWER ALARM LIMIT button to return to the service mode steady state.

14. Select menu item 34 by rotating the knob until “34” appears in the SpO_2% display.

15. Press the UPPER ALARM LIMIT button.

16. Verify that the SpO_2 red LED drive value “170” is displayed in the HEART/PULSE RATE display and that the IR indicator on the SRC-2 is illuminated.

17. Rotate the control knob to adjust the red LED drive level to “255”.

18. Press the UPPER ALARM LIMIT button and verify that the LED intensity increases.

19. Rotate the knob to adjust the red LED drive level to “0”.

20. Press the UPPER ALARM LIMIT button and verify that the RED indicator turns off.

21. Rotate the knob to adjust the red LED drive level back to “170”.

22. Press the UPPER ALARM LIMIT button and verify that the RED indicator intensity increases.

23. Press the LOWER ALARM LIMIT button to return to the service mode steady state.

24. Press the ON/STANDBY button to turn the N-3000 off.

3.3.4.2 Operation with an ECG Simulator

1. With the monitor off, connect the ECG leads RA, LA, and LL to the appropriate jacks on the ECG tester.

   Nellcor Puritan Bennett ECG leads are color-coded as follows:

   Right arm (RA) - white
   Left arm (LA) - Black
   Left leg (LL) - Red

2. Connect the leads to the SCE-10 ECG cable. Connect the SCE-10 to the ECG input port on the N-3000. Set the ECG tester as follows:

PARAMETER	**SETTING**
HEART RATE	30 bpm
AMPLITUDE	1 millivolt
LEAD SELECT	I
SINUS RHYTHM	Normal
RCAL/MODE	Adult

Note: The accuracy of N-3000 ECG measurements is ± 5 bpm. In the procedure below, add the tolerance of the simulator to the acceptable range of readings.

3. Ensure that the monitor is connected to an AC power source. Press the ON/STANDBY button to turn the monitor on. After the normal power-up sequence, verify the following monitor reactions:

   a. The heart rate “beep” will be heard.

   b. After at least five heartbeats, the monitor displays a heart rate of 30 ± 5 bpm.

   c. The audible alarm will sound and the HEART/PULSE RATE display will flash, indicating the heart rate is below the default lower alarm limit. The heart rate “beep” can still be heard.

4. Press the AUDIBLE ALARM OFF BUTTON. Verify that the alarm is silenced.

5. Increase the heart rate setting on the ECG simulator to 240 bpm. Verify that the rate of beeps increases and the HEART/PULSE RATE display value increases.

6. After at least five heartbeats, verify that the monitor displays a heart rate of 240 ± 5 bpm.

7. Verify that the audible alarm sounds and the HEART/PULSE RATE display flashes, indicating that the heart rate is above the default upper alarm limit.

8. Press AUDIBLE ALARM OFF button to silence the alarm.

9. Decrease the heart rate setting on the ECG simulator to 120 bpm.

10. After at least five heartbeats, verify that the monitor displays a heart rate of 120 ± 5 bpm.

11. Disconnect the LL lead from the ECG simulator. Verify that the LEADS OFF indicator lights, three dashes are displayed in the HEART/PULSE RATE display, and a low priority audible alarm sounds.

12. Reconnect the LL lead to the ECG simulator. Verify that the LEADS OFF indicator is no longer lit and that the alarm is silenced.

    Note: Depending on the lead used and pleth configuration, the HEART/PULSE RATE display may revert to a pulse rate as leads are removed in step 11. If a medium priority alarm results and is silenced, the low priority alarm from leads off will not break through.

13. Repeat steps 11 and 12 for the LA and RA leads.

14. Turn the monitor off.

3.3.4.3 Operation with a Respiration Simulator

1. With the monitor off, connect the *Nellcor Puritan Bennett* ECG leads to the appropriate jacks on the respiration simulator.

2. Connect the leads to the SCE-10 ECG cable. Connect the SCE-10 to the ECG input port on the N-3000.

    Note: The accuracy of N-3000 ECG measurements is $\pm$ 3 breaths per minute. In the procedure below, add the tolerance of the simulator to the acceptable range of readings.

3. Set the simulator for a respiration rate of 100 breaths per minute.

4. Ensure that the monitor is connected to an AC power source. Press the ON/STANDBY button to turn the monitor on. After the normal power-up sequence, verify the following monitor reactions:

    a. After about 20-25 seconds, the monitor displays a respiration rate of 100 ± 3 breaths per minute.

    b. The audible alarm will sound and the RESPIRATION RATE display will flash, indicating the respiration rate is above the default upper alarm limit.

5. Press the AUDIBLE ALARM OFF BUTTON. Verify that the alarm is silenced.

6. Decrease the respiration rate setting on the respiration simulator to 20 breaths per minute.

7. After at least 5 breaths, verify that the monitor displays a respiration rate of 20 ± 3 breaths per minute.

8. Power down the monitor and disconnect it from the simulator.

3.3.4.4 General Operation

The following tests are an overall performance check of the system:

- 3.3.4.4.1 LED Excitation Test
- 3.3.4.4.2 Operation with a Live Subject
- 3.3.4.4.3 Serial Interface Test
- 3.3.4.4.4 Piezo Speaker Test
- 3.3.4.4.5 Persistent Time Clock Test

- 3.3.4.4.6 ECG Cable Test

3.3.4.4.1 LED Excitation Test

This procedure uses normal system components to test circuit operation. A *Nellcor Puritan Bennett™ Oxisensor II®* oxygen transducer, model D-25, is used to examine LED intensity control. The red LED is used to verify intensity modulation caused by the LED intensity control circuit.

1. Connect the monitor to an AC power source through the SPS-N1 or PSS-1 power supply.
2. Connect an SCP-10 sensor input cable to the monitor.
3. Connect a D-25 sensor to the sensor input cable.
4. Press the ON/STANDBY button to turn the monitor on.
5. Leave the sensor open with the LEDs and photodetector visible.
6. After the monitor completes its normal power-up sequence, verify that the sensor LED is brightly lit.
7. Slowly move the sensor LED in proximity to the photodetector element of the sensor. Verify, as the LED approaches the optical sensor, that the LED intensity decreases.
8. Open the sensor and notice that the LED intensity increases.
9. Repeat step 7 and the intensity will again decrease. This variation is an indication that the microprocessor is in proper control of LED intensity.
10. Turn the N-3000 off.

3.3.4.4.2 Operation with a Live Subject

Patient monitoring involves connecting the monitor to a live subject for a qualitative test.

1. Ensure that the monitor is connected to an AC power source through the SPS-N1 or PSS-1 power supply.
2. Connect an SCP-10 sensor input cable to the monitor.
3. Connect a *Nellcor Puritan Bennett™ Durasensor®* oxygen transducer, model DS-100A, to the sensor input cable.
4. Clip the DS-100A to the subject as recommended in the sensor directions for use.
5. Connect ECG electrodes to the patient.
6. Connect an SCE-10 ECG cable to the N-3000. Connect ECG leads to the cable.
7. Connect the ECG leads to the electrodes on the patient according to the leads directions for use.

8. Press the ON/STANDBY button to turn the monitor on and verify that the monitor is operating.

9. The monitor should stabilize on the subject's physiological signal in about 15 to 30 seconds. Verify that the saturation and heart and respiration rates are reasonable for the subject.

3.3.4.4.3 Serial Interface Test

The communications submodule of the N-3000, using an asynchronous EIA-232 communications format, allows communications between the N-3000 and a PC via the 6-pin connector on the rear panel of the N-3000, as illustrated in Figure 3-2. An SAK-232 cable and detailed directions for use are available by contacting your local Nellcor Puritan Bennett representative.

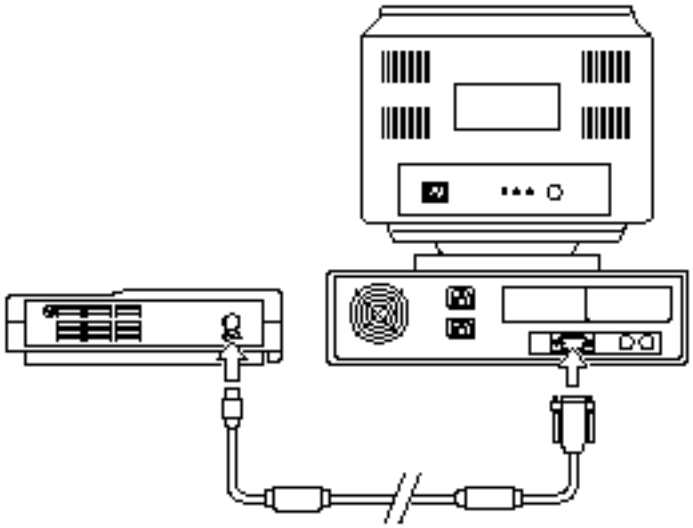


Figure 3-2: Serial Port Interface

The two configurable options of serial data interface are RS-232 and EIA-422. The N-3000 is shipped with the RS-232 setting. To change the settings, refer to paragraph 6.5.1.

Perform the following procedure to test the serial port voltages. The test is qualitative and will only verify that the serial interface port is powered correctly.

1. Connect the monitor to an AC power source through the SPS-N1 or PSS-1 power supply and turn the monitor on.

2. Connect a 6-pin miniature connector adapter to the serial interface port.

3. Set up the DMM with the function set to "VDC" at a range of 10 volts.

4. Connect the DMM negative lead to connector pin 4 (GND).

5. Connect the DMM positive lead to the following pins and verify the voltage values listed in Table 3-2. If the voltages are not as indicated, follow the procedures in paragraph 5.6.7.

Figure 3-3: Serial Port Connector - External Pin Locations

Table 3-2: Serial Port Voltages

Pin	Line	Voltage
1	DTR	7.5 ± 2.5
2	DSR	0.0 ± 0.4
3	TXD	-7.5 ± 2.5
4	GND	0.0 ± 0.4
5	RXD	0.0 ± 0.4
6	Alarm Active	0.0 ± 0.4 or 3.3 ± 0.4

3.3.4.4.4 Piezo Speaker Test

The following test verifies that the Piezo power-loss alarm speaker sounds when the N-3000 loses power.

WARNING: Before attempting to open or disassemble the N-3000, disconnect the power cord from the N-3000.

Caution: Observe ESD (electrostatic discharge) precautions when working within the monitor.

1. Ensure that the N-3000 is turned off.
2. Disconnect the monitor from the external power supply.
3. Set the N-3000 upside down facing you, as shown in Figure 3-4.

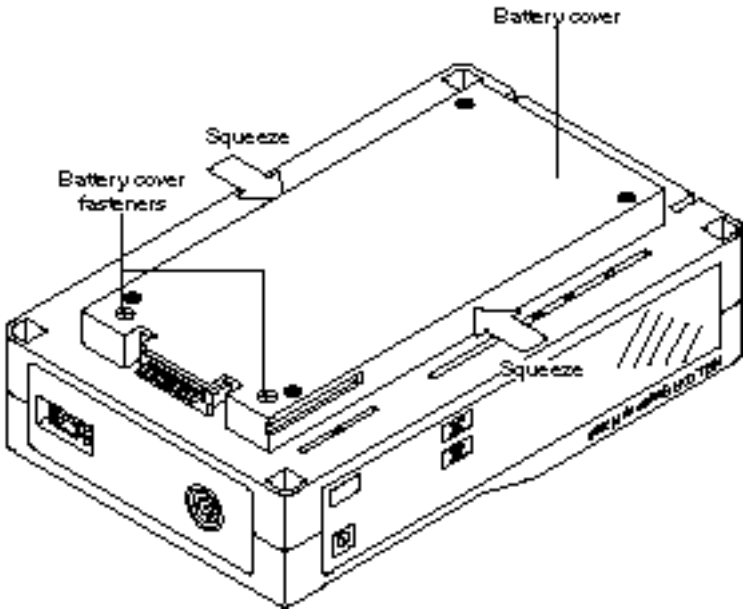


Figure 3-4: Battery Cover Removal

4. Using a small, Phillips-head screwdriver, loosen the two battery cover retaining fasteners securing the battery compartment cover.
5. Gently squeeze the battery cover sides in the middle as you swing the cover open (it is hinged on the right with three tabs that extend into slots on the chassis).

6. Lift the battery out of the compartment, as shown in Figure 3-5. It may be necessary to use the edge of a flat tip screwdriver to gently pry the battery loose.

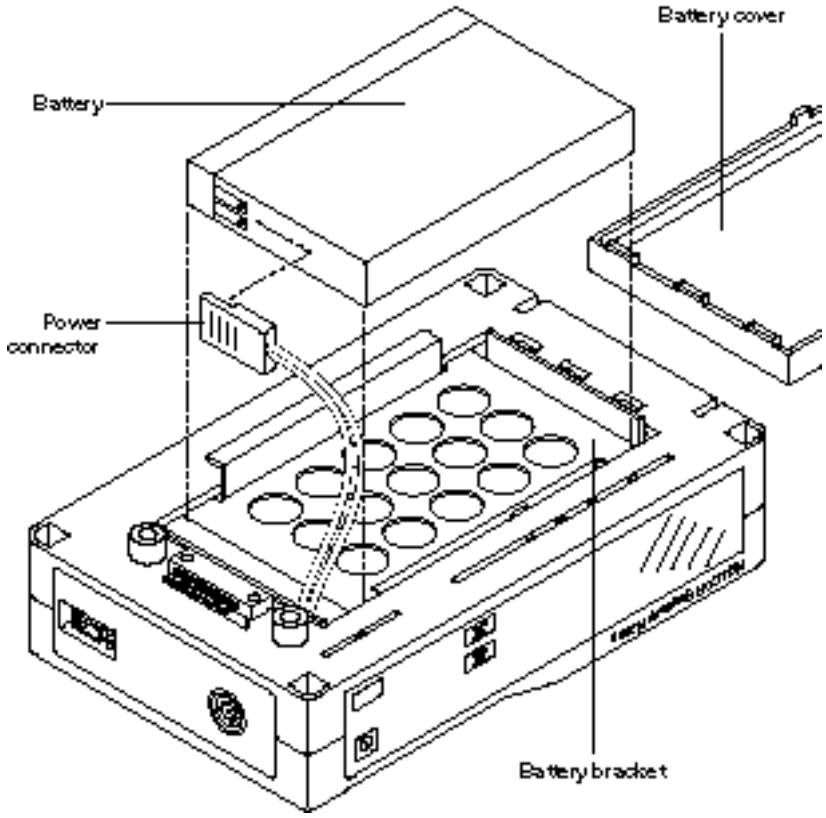


Figure 3-5: Speaker Test

7. Turn the monitor on by pressing the ON/STANDBY button.

8. When the power-on self-test is complete, disconnect the power connector from the battery. Verify that a shrill, beeping alarm is emitted from the speaker.

9. Reconnect the power connector to the battery. Verify that the alarm is silenced and the monitor powers back on.

10. Disconnect the power connector from the battery a second time. Verify that the Piezo alarm sounds.

11. Press the AUDIBLE ALARM OFF button and verify that the alarm is silenced.

12. Reconnect the power connector to the battery. Verify that the alarm remains silent and the monitor powers back on.

13. Turn the monitor off by pressing the ON/STANDBY button.

14. Replace the battery in the battery bracket and reconnect the battery cover.

3.3.4.4.5 Persistent Time Clock Test

This procedure allows you to check the operation of the persistent time clock.

1. Enter the service mode as follows:

   a. While holding down the UPPER and LOWER ALARM LIMIT buttons and the PRINT button, press and release the ON/STANDBY button. Continue to hold the UPPER and LOWER ALARM LIMIT and PRINT buttons while the monitor performs the power-on test.

   b. When “SEr” begins flashing in the AUXILIARY display, release the UPPER and LOWER ALARM LIMIT and PRINT buttons.

   c. Press the PRINT button within 15 seconds or the monitor will turn off automatically. The number “1” appears in the SpO_2% display. You are now in the service mode steady state.

2. Select menu item 19 by rotating the control knob.

3. Press the UPPER ALARM LIMIT button. The persistent time in seconds is displayed in the SpO_2% and HEART/PULSE RATE displays. For example, “001 688” indicates that the monitor has been powered on for 1,688 seconds = 28 minutes, 8 seconds. Verify that the right-most digit is counting seconds.

   If the display reads “999 999”, this indicates that persistent time is greater than or equal to 999,999 seconds. If dashes are displayed, the contents of the memory of the persistent time circuit are lost. This can occur when the backup lithium battery has been replaced.

4. Using a timepiece, track the clock to verify proper operation.

5. Press the LOWER ALARM LIMIT button to return to the service mode steady state.

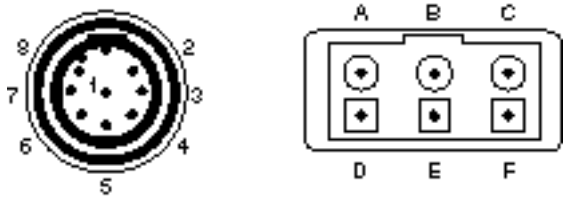
6. Turn the monitor off by pressing the ON/STANDBY button.

3.3.4.5 ECG Cable Test

The following test should be completed after defibrillation has been performed on a patient attached to ECG leads and a *Nellcor Puritan Bennett* SCE-10 ECG cable. It does not need to be performed as a component of an N-3000 performance verification test.

Perform the following procedure to test the ECG cable.

1. Disconnect the SCE-10 ECG cable from the N-3000 and the ECG leads. Pin locations for both ends of the ECG cable are identified in Figure 3-6.



N-3000 Connector ECG Lead Connector

Figure 3-6: ECG Cable Pin Locations

2. Measure the resistances between the pins as indicated in Table 3-3.

Table 3-3: ECG Cable Resistances

Pin	To Pin	Resistance
2	A	900 - 1100 ohms
3	B	900 - 1100 ohms
8	C	900 - 1100 ohms
5	D, E, F	0 - 5 ohms
8	5	open
2	5	open
3	5	open
A	D	open
B	E	open
C	F	open

3. If the resistances are not as indicated, replace the cable.

3.4 SAFETY TESTS

N-3000 safety tests consist of:

- Ground Integrity
- Electrical Leakage

3.4.1 Ground Integrity

This test verifies the integrity of the power cord ground wire from the AC plug and connection with the external power supply chassis ground.

1. Configure the electrical safety analyzer as follows:

   Function: Ground resistance test
   Range: Milliohms

2. Connect the monitor's AC plug to the analyzer as recommended by the analyzer operating instructions.

3. Connect the analyzer "resistance" input lead to the grounding lug on the rear panel of the external power supply. Verify that the analyzer indicates 150 milliohms or less.

3.4.2 Electrical Leakage

The following tests verify the electrical leakage of the monitor.

- Chassis Source Current
- Patient Source Current
- Patient Sink Current

3.4.2.1 Chassis Source Current

This test is in compliance with IEC 601.1 and AAMI Standard ES1, paragraph 3.3.1, Chassis Source Current, between the power ground and (part b), exposed conductive hardware.

1. Configure the electrical safety analyzer as follows:

   Function: Leakage
   Range: Microamps

2. Connect the monitor AC plug to the electrical safety analyzer as recommended by the analyzer operating instructions.

3. Connect the electrical safety analyzer "leakage" input lead to the monitor's external power supply grounding lug.

   The analyzer leakage indication must not exceed 100 microamps at 100–120 VAC or 500 microamps at 220–240 VAC for the following AC power configurations while the monitor is turned on and while turned off.

AC LINE POLARITY	**POWER LINE GROUND CABLE**
Normal	Normal
Reverse	Normal
Reverse	Open
Normal	Open

3.4.2.2 Patient Source Current

This test is in compliance with AAMI Standard ES1, paragraph 3.3.2. Patient Source Current is measured between any individual patient connection and power (earth) ground.

1. Configure the electrical safety analyzer as follows:

   Function: Leakage
   Range: Microamps

2. Connect the monitor AC plug to the electrical safety analyzer as recommended by the analyzer operating instructions for patient source current.

3. Connect the electrical safety analyzer leakage input lead to the monitor's sensor input connector.

   The analyzer leakage indication must not exceed 10 microamps for all of the following AC power configurations with the monitor on.

AC LINE POLARITY	**POWER LINE GROUND CABLE**
Normal	Normal
Reverse	Normal
Reverse	Open

Normal	Open

3.4.2.3 Patient Sink Current

This test is in compliance with AAMI Standard ES1, paragraph 4.4. Patient sink current is measured in a patient connection if a source of 240 volts, 50 Hz (or 120 volts, 60 Hz) with respect to power (earth) ground, is connected to that patient connection.

1. Configure the electrical safety analyzer as follows:

   Function: Leakage
   Range: µA

2. Connect the monitor AC plug to the electrical safety analyzer as recommended by the operating instructions for patient sink current.

3. Connect the electrical safety analyzer leakage input lead to the monitor's sensor input.

   The analyzer leakage indication must not exceed 50 microamps for 240 volts (10 microamps for 120 volts) for the following AC power configurations with the monitor on.

AC LINE POLARITY	**POWER LINE GROUND CABLE**
Normal	Normal
Normal	Open

SECTION 4: CONFIGURATION MODE, SERVICE MODE, AND ALARM ACTIVE FUNCTION

4.1 Introduction
4.2 Configuration Mode
4.3 Service Mode
4.4 Alarm Active Function

4.1 INTRODUCTION

This section discusses use of the configuration mode to reconfigure power-on default values, the service mode to identify and correct monitor difficulties, and the alarm active function.

4.2 CONFIGURATION MODE

The following paragraphs describe how to enter the N-3000 configuration mode and change factory power-on default settings.

The N-3000 cannot enter the configuration mode while it is stacked unless the other instruments are in the configuration mode or are turned off. If the other instruments are in the configuration mode, the N-3000 knob may be used to scroll to the desired menu item and adjust the settings of the other instruments. Likewise, if the N-3000 is stacked with an N-3200, and both are in the configuration mode, the N-3200 knob may be used to scroll to the desired menu item and adjust the settings of the N-3000.

Use the following procedure to enter configuration mode:

1. If the monitor is on, turn it off.

2. While simultaneously pressing both UPPER and LOWER ALARM LIMIT buttons, turn the monitor on. Continue to press both buttons until “CFG” begins flashing in the RESPIRATION RATE display.

3. Release the UPPER and LOWER ALARM LIMIT buttons.

4. Press the PRINT button. “CFG” stops flashing and remains displayed in the RESPIRATION RATE display. (If the PRINT button is not pressed within 15 seconds after “CFG” begins flashing, the monitor will turn off automatically.)

You are now in configuration mode steady state. The N-3000 automatically powers down if no action is taken for approximately 2 minutes.

After changing or viewing a default setting, you can return to the configuration mode steady state by allowing the display to timeout (3 seconds).

To exit the configuration mode, turn the monitor off by pressing the ON/STANDBY button. Default settings take place when the monitor is turned off. Default settings also take place if the N-3000 powers down due to the 2-minute timeout.

Note: While changing default limits, there must be some user interaction with the monitor within a 3-second period or the monitor will return to configuration mode steady state operation.

Table 4-1 lists the default settings that can be configured and the respective entry procedures to access the settings. Methods used to change the default settings are detailed in paragraphs 4.2.1 through 4.2.10.

Table 4-1: Configuration Mode Menu

Power on Default Setting	Button Press Procedure from Configuration Mode Steady State	Paragraph Described
Adult/Neonatal Mode	NEW PATIENT/NEONATAL button twice	4.2.1
SpO_2 Upper Alarm Limit	UPPER ALARM LIMIT button	4.2.2
SpO_2 Lower Alarm Limit	LOWER ALARM LIMIT button	4.2.3
Heart/Pulse Rate Upper Alarm Limit	UPPER ALARM LIMIT button twice	4.2.4
Heart/Pulse Rate Lower Alarm Limit	LOWER ALARM LIMIT button twice	4.2.5
Respiration Rate Upper Alarm Limit	UPPER ALARM LIMIT button three times	4.2.6
Respiration Rate Lower Alarm Limit	LOWER ALARM LIMIT button three times	4.2.7
Alarm Volume	ALARM SILENCE button (press and hold for 3 seconds before turning knob)	4.2.8
Alarm Silence Duration	ALARM SILENCE button (press and hold; turn knob within 3 seconds)	4.2.9
Configuration Menu	UPPER/LOWER ALARM LIMIT buttons simultaneously	4.2.10

Note: To change neonate default limits, enter the neonatal mode from configuration mode steady state by pressing the NEW PATIENT/NEONATAL button twice within 2 seconds. Change the desired limit using the same method as adult default limits.

When an SpO_2 or heart/pulse rate default limit has been changed, a decimal point will appear after the displayed limit until the configuration mode is exited.

4.2.1 Adult/Neonatal Mode Default

The mode (adult or neonatal) that the monitor is in when exiting the configuration mode, becomes the power-on default.

To change from a power-on default of adult mode to a power-on default of neonatal mode, enter the configuration mode steady state. Press the NEW PATIENT/NEONATAL button twice within 2 seconds and then power-down by pressing the ON/STANDBY button.

4.2.2 Default SpO_2 Upper Alarm Limit

1. From the configuration mode steady state, press and release the UPPER ALARM LIMIT button. The current default value is displayed in the SpO_2% display. Dashes appear in the HEART/PULSE RATE display (the upper horizontal segments of the display), indicating that the monitor is in the “set SpO_2 upper alarm limit” mode.

2. To change the upper alarm limit default value, rotate the knob on top of the monitor (or, if stacked with an N-3200 in the configuration mode, the knob on the N-3200). You cannot decrease the value lower than the current SpO_2 lower alarm limit default setting. The SpO_2 upper alarm limit cannot be set higher than 100.

3. Return to configuration mode steady state.

   Note: If you press the LOWER ALARM LIMIT button before the 3-second timeout, you can then change the SpO_2 lower alarm limit default. If you press the UPPER ALARM LIMIT button, you can then change the pulse rate upper alarm limit default. This method can also be used while setting the other default alarm limits.

4.2.3 Default SpO_2 Lower Alarm Limit

1. From the configuration mode steady state, press and release the LOWER ALARM LIMIT button. The current default value is displayed in the SpO_2% display.

2. To change the lower alarm limit default value, rotate the knob on top of the monitor. You cannot increase the value higher than the current SpO_2 upper alarm limit setting. The SpO_2 default lower alarm limit cannot be set lower than 80.

3. Return to the configuration mode steady state.

4.2.4 Default Heart/Pulse Rate Upper Alarm Limit

1. From the configuration mode steady state, press the UPPER ALARM LIMIT button twice within 3 seconds. The current default value is displayed in the HEART/PULSE RATE display. Dashes appear in the SpO_2% display (the upper horizontal segments of the display), indicating that the monitor is in the “set pulse rate upper alarm limit” mode.

2. To change the upper alarm limit default value, rotate the control knob on top of the monitor. You cannot decrease the value lower than the current pulse rate lower alarm limit default setting. The pulse rate default upper alarm limit cannot be set higher than 250.

3. Return to configuration mode steady state.

4.2.5 Default Heart/Pulse Rate Lower Alarm Limit

1. From the configuration mode steady state, press the LOWER ALARM LIMIT button twice within 3 seconds. The current default value is displayed in the HEART/PULSE RATE display.

2. To change the default lower alarm limit value, rotate the knob CW to increase, or CCW to decrease. You cannot increase the value higher than the current pulse rate upper limit setting. The pulse rate lower alarm limit cannot be set lower than 30.

3. Return to the configuration mode steady state.

4.2.6 Default Respiration Rate Upper Alarm Limit

1. From the configuration mode steady state, press the UPPER ALARM LIMIT button three times within 3 seconds. The current default value is displayed in the RESPIRATION RATE display.

2. To change the default upper alarm limit value, rotate the control knob on top of the monitor CW to increase or CCW to decrease. You cannot decrease the value lower than the current respiration rate lower limit setting. The respiration rate upper alarm limit cannot be set higher than 150.

3. Return to the configuration mode steady state.

4.2.7 Default Respiration Rate Lower Alarm Limit

1. From the configuration mode steady state, press the LOWER ALARM LIMIT button three times within three seconds. The current default value is displayed in the RESPIRATION RATE display.

2. To change the default lower alarm limit value, rotate the knob CW to increase, or CCW to decrease. You cannot increase the value higher than the current respiration rate upper limit setting. The respiration rate lower alarm limit cannot be set lower than 3.

   To set the default respiration setting to OFF, rotate the knob CCW past 3. OFF is displayed in the RESPIRATION RATE display and respiration monitoring is disabled in the current mode (adult or neonatal).

3. Return to the configuration mode steady state.

4.2.8 Default Alarm Volume

Perform the following steps to adjust the default alarm volume:

1. From the configuration mode steady state, press and hold the AUDIBLE ALARM OFF button. After 3 seconds, a continuous tone at the current volume setting is emitted. “VOL” is displayed in the HEART/PULSE RATE display, and the current default alarm setting (a number from 1 to 10) is displayed in the SpO_2% display.

2. While continuing to hold the AUDIBLE ALARM OFF button, turn the control knob on the top of the monitor CW to increase the default volume, CCW to decrease the default volume.

3. Release the AUDIBLE ALARM OFF button and the monitor returns to the configuration mode steady state.

4.2.9 Default Alarm Silence Duration

The default alarm silence duration may also be adjusted while in the configuration mode. To do so:

1. From the configuration mode steady state, press and hold the AUDIBLE ALARM OFF button for 3 seconds or less. The current default setting for the alarm silence duration appears in the HEART/PULSE RATE display. The SpO_2% display indicates “CFG”, while the RESPIRATION RATE display indicates “SEC” (seconds).

Note: Pressing the AUDIBLE ALARM OFF button for more than 3 seconds without turning the knob, causes the N-3000 to enter the "Default Alarm Volume" mode as described in paragraph 4.2.8.

2. Use the control knob on the top of the N-3000 to adjust the default alarm silence duration. Alarm silence duration choices are 30 SEC, 60 SEC, 90 SEC, and 120 SEC.

4.2.10 Configuration Menu

The configuration menu allows you to configure the functions listed in Table 4-2. After accessing a menu item by pressing the UPPER ALARM LIMIT button, if the knob is not turned and no button is pressed for a period of time equal to the "timeout" as listed in the table, you will automatically return to the configuration menu steady state. The last setting displayed for the menu item will become the default setting.

Table 4-2: Configuration Menu

Menu Number	Configurable Setting	Paragraph Described	Timeout
0	Pulse tone volume	4.2.10.1	3 seconds
1	UIF software version report	4.2.10.2	10 seconds
2	SpO_2 software version report	4.2.10.3	10 seconds
3	Serial port baud rate	4.2.10.4	3 seconds
4	Trend type	4.2.10.5	3 seconds
5	Reset to factory defaults	4.2.10.6	N/A
6	Primary heart/pulse rate source	4.2.10.7	3 seconds
7	Primary pulse tone source	4.2.10.8	3 seconds
8	ECG lead selection	4.2.10.9	3 seconds
9	ECG pacer filter status	4.2.10.10	3 seconds
10	ECG low frequency filter status	4.2.10.11	3 seconds
11	ECG software version report	4.2.10.12	10 seconds
12	Respiration noise timeout	4.2.10.13	3 seconds
13	Respiration sensitivity selection	4.2.10.14	3 seconds

To access the configuration menu from the configuration mode steady state, press the UPPER and LOWER ALARM LIMIT buttons simultaneously. The SpO_2% display indicates the menu number (0 through 13) and the PATIENT MOTION indicator is illuminated to indicate the monitor is in the configuration menu steady state.

Rotate the knob on top of the N-3000 to access the desired menu number. Press the UPPER ALARM LIMIT button to configure the displayed item, using the procedures listed in paragraphs 4.2.10.1 through 4.2.10.14.

To exit the configuration menu steady state and return to the configuration mode steady state, press the LOWER ALARM LIMIT button or, if there is no knob or button activity for 15 seconds, you will automatically return to the configuration mode steady state. You may also exit by turning the monitor off.

4.2.10.1 Pulse Tone Volume

Menu item number "0" allows you to set the default volume (1 through 10) for the pulse tone.

1. From the configuration menu steady state, rotate the knob until "0" is displayed in the SpO_2% display. Press the UPPER ALARM LIMIT button.

2. The current default pulse tone volume setting is displayed in the HEART/PULSE RATE display. An audio tone sounds at the current volume setting Rotate the knob CW or CCW to set the desired power-on default volume level (1 through 10).

3. Press the LOWER ALARM LIMIT BUTTON to return to the configuration menu steady state.

4.2.10.2 UIF Software Version Report

1. From the configuration menu steady state, rotate the knob until "1" is displayed in the SpO_2% display. Press the UPPER ALARM LIMIT button.

2. The UIF software version number is the six digit number in the SpO_2% and HEART/PULSE RATE displays.

3. Press the LOWER ALARM LIMIT BUTTON to return to the configuration menu steady state.

4.2.10.3 SpO_2 Software Version Report

1. From the configuration menu steady state, rotate the knob until "2" is displayed in the SpO_2% display. Press the UPPER ALARM LIMIT button.

2. The SpO_2 software version number is the six digit number in the SpO_2% and HEART/PULSE RATE displays.

3. Press the LOWER ALARM LIMIT BUTTON to return to the configuration menu steady state.

4.2.10.4 Serial Port Baud Rate

1. From the configuration menu steady state, rotate the knob until "3" is displayed in the SpO_2% display. Press the UPPER ALARM LIMIT button.

2. The current baud rate, in thousands, is displayed in the HEART/PULSE RATE display. To change the default baud rate setting, rotate the knob until the desired setting is displayed. Baud rates available are 1.2k, 2.4k, 9.6k, 19.2k, and 38.4k.

   Note: Baud rates should not exceed 19,200 in RS-232 mode (use EIA-422 mode). Refer to paragraph 6.5.1 to change the communication mode settings.

3. Press the LOWER ALARM LIMIT button to return to the configuration menu steady state.

4.2.10.5 Trend Type

Patient trend information can be accessed by attaching the N-3000 to an N-3200. It is also available for a PC via the serial port.

Menu item number 4 allows you to select “5”, “10” or “20” (displayed in the SpO_2% display) as the default trend format. Selecting “20” causes patient trend data to be recorded every 20 seconds. Each patient parameter value will be both the maximum and minimum data for each parameter during the sample period. Data is stored for the most recent 32 hours of patient monitoring during the last five days. This selection is described as “Format 2” in the N-3000 operator’s manual.

Selecting “10” causes patient trend data to be recorded every 10 seconds. Each patient parameter value will be the average of all data samples for each parameter during the sample period. Data is stored for the most recent 24 hours of patient monitoring during the last five days. This selection is described as “Format 1” in the N-3000 operator’s manual.

Selecting “5” causes patient trend data to be recorded every 5 seconds. Each patient parameter value will be the most recent data sample for each parameter during the sample period. Data is stored for the most recent 12 hours of patient monitoring during the last five days. This selection is described as “Format 3” in the N-3000 operator’s manual.

1. From the configuration menu steady state, rotate the knob until “4” is displayed in the SpO_2% display. Press the UPPER ALARM LIMIT button.

2. “5”, “10” or “20” is displayed in the HEART/PULSE RATE display. Rotate the knob to display the desired default trend type.

3. Press the LOWER ALARM LIMIT BUTTON to return to the configuration menu steady state.

4.2.10.6 Reset to Factory Defaults

Menu item number 5 allows you to reset all default settings to the original factory settings as listed in paragraph 9.6, “Factory Default Settings,” of the *Specifications* section.

1. From the configuration menu steady state, rotate the knob until “5” is displayed in the SpO_2% display.

2. Press the UPPER ALARM LIMIT button to reset to factory defaults. Three beeps indicate that all configurable power-on default parameters, except latching alarms and alarm silence reminder enable, are set to their factory default values. You are automatically returned to the configuration menu steady state.

4.2.10.7 Primary Heart/Pulse Rate Source

Menu item number “6” allows you to select the default primary heart/pulse rate source. Selecting “SPO” causes the pulse rate measured by an SpO_2 sensor to be used as the primary source displayed in the HEART/PULSE RATE display.

Selecting “ECG” causes the heart rate measured by ECG leads to be used as the primary source displayed in the HEART/PULSE RATE display.

1. From the configuration menu steady state, rotate the knob until “6” is displayed in the SpO_2% display. Press the UPPER ALARM LIMIT button.

2. The current primary heart/pulse rate source is displayed in the HEART/PULSE RATE. “ECG” indicates that the primary source is the heart rate as measured with the ECG leads. “SPO” indicates that the primary source is the pulse rate as measured by the SpO_2 sensor. To change the default setting, rotate the knob until the desired setting is displayed.

3. Press the LOWER ALARM LIMIT button to return to the configuration menu steady state.

4.2.10.8 Primary Pulse Tone Source

Menu item number “7” allows you to select the default heart/pulse tone source. Selecting “SPO” causes the pulse rate measured by an SpO_2 sensor to provide the pulse tone. Selecting “ECG” causes the heart rate measured by ECG leads to provide the pulse tone.

1. From the configuration menu steady state, rotate the knob until “7” is displayed in the SpO_2% display. Press the UPPER ALARM LIMIT button.

2. The current pulse tone source is displayed in the HEART/PULSE RATE display. “ECG” indicates that the source is the heart beat as measured with the ECG leads. “SPO” indicates that the source is the pulse beat as measured by the SpO_2 sensor. To change the default setting, rotate the knob until the desired setting is displayed.

3. Press the LOWER ALARM LIMIT button to return to the configuration menu steady state.

4.2.10.9 ECG Lead Selection

Menu item number “8” allows you to select the default ECG leads option. The leads option allows detection of the electrical signal generated by the heart along different axes through the heart. Selections are “1” (lead I, LA-RA), “2” (lead II, LL-RA) or “3” (lead III, LL-LA).

1. From the configuration menu steady state, rotate the knob until “8” is displayed in the SpO_2% display. Press the UPPER ALARM LIMIT button.

2. “1”, “2”, or “3” is displayed in the HEART/PULSE RATE display. To change the default setting, rotate the knob until the desired setting is displayed.

3. Press the LOWER ALARM LIMIT button to return to the configuration menu steady state.

4.2.10.10 ECG Pacer Filter Status

Menu item number “9” allows you to select either “ON” or “OFF” as the pacer filter default. Pacer filter “ON” causes the N-3000 to detect and filter pacemaker generated noise signals so that they will not be measured in determining a patient’s heart rate. When the filter is “ON”, pacemaker signals of .1 to 2.0 milliseconds in duration with 2.0 to 700.0 millivolt amplitude are filtered out.

1. From the configuration menu steady state, rotate the knob until “9” is displayed in the SpO_2% display. Press the UPPER ALARM LIMIT button.

2. “ON” or “OFF” is displayed in the HEART/PULSE RATE display. To change the default setting, rotate the knob until the desired setting is displayed.

3. Press the LOWER ALARM LIMIT button to return to the configuration menu steady state.

4.2.10.11 ECG Low Frequency Filter Status

Menu item number “10” allows you to select “ON” or “OFF” as the low frequency filter default. Selecting “ON” enables a .05 Hz, ECG channel, high-pass filter, providing better ST segment resolution. When “OFF” is selected, a 0.5 Hz filter is used.

1. From the configuration menu steady state, rotate the knob until “10” is displayed in the SpO_2% display. Press the UPPER ALARM LIMIT button.

2. “ON” or “OFF” is displayed in the HEART/PULSE RATE display. To change the default setting, rotate the knob until the desired setting is displayed.

3. Press the LOWER ALARM LIMIT button to return to the configuration menu steady state.

4.2.10.12 ECG Software Version Report

1. From the configuration menu steady state, rotate the knob until “11” is displayed in the SpO_2% display. Press the UPPER ALARM LIMIT button.

2. The ECG software version number is the six digit number in the SpO_2% and HEART/PULSE RATE displays.

3. Press the LOWER ALARM LIMIT BUTTON to return to the configuration menu steady state.

4.2.10.13 Respiration Noise Timeout

Menu item number “12” allows you to select “5”, “10”, “15”, “20”, “25” or “30” seconds as the default adult mode setting for the amount of time before a low priority alarm is sounded when respiration noise is detected. The 25-second and 30-second selections are not available in the neonate mode.

1. From the configuration menu steady state, rotate the knob until “12” is displayed in the SpO_2% display. Press the UPPER ALARM LIMIT button.

2. “5”, “10”, “15”, “20”, “25” or “30” is displayed in the SpO_2% display. (“25” and “30” are not displayed in the neonatal mode.) Rotate the knob to display the desired default respiration noise timeout.

3. Press the LOWER ALARM LIMIT BUTTON to select the displayed setting and return to the configuration menu steady state.

4.2.10.14 Respiration Sensitivity Selection

Menu item number “13” allows you to adjust the sensitivity setting of the respiration detection circuitry. Selectable settings are 1, 2, 3, or 4, with 1 being the least sensitive and 4 the most sensitive. Decreasing the sensitivity setting

decreases the possibility that movement might be interpreted by the N-3000 as respiration, but also decreases the capability of the N-3000 to pick up light breathing. The default setting is “4”.

1. From the configuration menu steady state, rotate the knob until “13” is displayed in the SpO_2% display. Press the UPPER ALARM LIMIT button.

2. “1”, “2”, “3”, or “4” is displayed in the SpO_2% display. Rotate the knob to display the desired respiration sensitivity.

3. Press the LOWER ALARM LIMIT BUTTON to select the displayed setting and return to the configuration menu steady state.

4.3 SERVICE MODE

The service mode allows the technician to go through a series of tests to determine monitor functionality and to access the error log report.

The service modes cannot be accessed by the N-3000 while it is stacked with an active N-3100 or N-3200. If operating in the stacked configuration, disconnect the N-3000 from other instruments or turn the other instruments off before entering the service mode.

Use the following procedures to place the monitor into the service mode:

1. If the monitor is on, turn it off.

2. While simultaneously holding down the UPPER and LOWER ALARM LIMIT buttons and the PRINT button, press and release the ON/STANDBY button. Continue to press and hold the UPPER and LOWER ALARM LIMIT and PRINT buttons while the monitor performs the power-on self-test.

3. When “SEr” begins flashing in the AUXILIARY display, release the UPPER and LOWER ALARM LIMIT and PRINT buttons.

4. Press the PRINT button. You must press this button within 15 seconds or the monitor will turn off automatically. You are now in service mode steady state.

   Note: Failure errors (refer to *Troubleshooting* section for an explanation of failure errors and error codes) may be encountered by the N-3000 upon entering the service mode. The N-3000 will automatically access the menu item used to correct this situation.

   If a user-correctable error code (a code beginning with “0”) is displayed while in the service mode, press the LOWER ALARM LIMIT button to clear the error.

   - “SEr” stops flashing and is continuously displayed.
   - The number “1” is indicated in the SpO_2% display.
   - The PATIENT MOTION indicator is lit, indicating that you are in the service mode steady state, with access to the main menu as indicated in Table 4-3.

5. Use the knob to move from one main menu item to the next.

   While in service mode, the UPPER and LOWER ALARM LIMIT buttons are used as enter and exit buttons, respectively. You must press the UPPER ALARM LIMIT button to select a main menu item and move to the submenu level.

6. When you have scrolled to the desired menu item, press the UPPER ALARM LIMIT button. The PATIENT MOTION indicator goes out and the PULSE SEARCH indicator illuminates.

   This indicates that you are now in a submenu of the selected main menu item. Use the knob to move from one submenu item to the next. Not all menu items have submenu selections.

7. To return to the service mode steady state from a menu item, press the LOWER ALARM LIMIT button. (Menu item 3, Button Test, is an exception; it is exited by rotating the knob.)

8. To exit the service mode, power-down the monitor by pressing the ON/STANDBY button. The N-3000 is automatically powered down if no action is taken for approximately 5 minutes.

Main menu items available from the service mode steady state are discussed in numerical order as indicated in Table 4-3.

Table 4-3: Service Mode Steady State - Main Menu

Menu No.	Type of Report/Test	Paragraph Described
1	Software Version Report	4.3.1
2	Knob and Lamp Test	4.3.2
3	Button Test	4.3.3
4	Speaker Test	4.3.4
5	Internal Configuration Code (ICC) Report	4.3.5
6	Total Operating Hours Report	4.3.6
7	Error Log Record 1	4.3.7
8	Error Log Record 2	4.3.7
9	Error Log Record 3	4.3.7
10	Error Log Record 4	4.3.7
11	Error Log Record 5	4.3.7
12	Error Log Record 6	4.3.7
13	Error Log Record 7	4.3.7
14	Error Log Record 8	4.3.7
15	Error Log Record 9	4.3.7
16	Error Log Record 10	4.3.7
17	Instrument Identification (IID) Report	4.3.8
18	Power Status	4.3.9
19	Persistent Time Sense Report	4.3.10
20	Reset to Factory Defaults	4.3.11
21	Initial Cluster Instrument Number Report	4.3.12
22	Latching Alarms	4.3.13
23	Enable/Disable Alarm Silence Reminder	4.3.14
25	Dump EEPROM Data	4.3.15
28	Enable/Disable Battery Charge Circuit	4.3.16
29	Instrument Compatibility Report	4.3.17
30	SpO_2 RCAL Report	4.3.18
31	SpO_2 IR and Red Offset Report	4.3.19
32	SpO_2 Corrected IR and Red Signals Report	4.3.20
33	SpO_2 IR LED Drive Test	4.3.21
34	SpO_2 Red LED Drive Test	4.3.22
35	SpO_2 DM-Gain Test	4.3.23
36	SpO_2 P-Gain Test	4.3.24
37	Set SpO_2 Analog Test Mode	4.3.25
38	SpO_2 A/D-Cal Line Test	4.3.26
39	SpO_2 Enable Automatic Operation	4.3.27

Table 4-3: Service Mode Steady State - Main Menu - (Continued)

Menu No.	Type of Report/Test	Paragraph Described
40	Set ECG Lead	4.3.28
41	Set ECG Pacer Filter	4.3.29
42	Set ECG Low Frequency Filter	4.3.30
43	Set ECG Baseline Reset	4.3.31
44	Set ECG POST Test Signal	4.3.32
45	Check ECG Cable Off Detection	4.3.33
46	Check ECG Lead Off Detection	4.3.34
47	Display ECG Output Value	4.3.35
49	ECG Enable Automatic Operation	4.3.36
51	Set Respiration Baseline Reset	4.3.37
53	Display Respiration Output Value	4.3.38
54	Enable/Disable Respiration Monitoring	4.3.39
55	Enable/Disable Breath Pulses	4.3.40
56	Respiration Enable Automatic Operation	4.3.41
60	Set Serial Port Baud Rate	4.3.42
61	Serial Port Loop Back Test	4.3.43
62	Serial Port Transmit Test	4.3.44
70	Nellcor Puritan Bennett Internal Test - *DO NOT USE*	

4.3.1 Menu Item 1: Software Version Report

This report identifies the software versions of the UIF and SpO_2 modules.

1. From the service mode steady state, select menu item 1 by rotating the *Nellcor Puritan Bennett* knob until “1” appears in the SpO_2% display. Press the UPPER ALARM LIMIT button. A “1.0” appears in the SpO_2% display.

   The UIF software version number is the six-digit number in the HEART/PULSE RATE and RESPIRATION RATE displays.

2. Rotate the knob to change the number in the SpO_2% display to “1.1”. The SpO_2 software version number is the six-digit number in the HEART/PULSE RATE and RESPIRATION RATE displays.

3. Rotate the knob to change the number in the SpO_2% display to “1.2”. The ECG software version number is the six-digit number in the HEART/PULSE RATE and RESPIRATION RATE displays.

   Note: Respiration software is a component of the ECG software.

4. Press the LOWER ALARM LIMIT button to return to the service mode steady state.

4.3.2 Menu Item 2: Knob and Lamp Test

This test verifies that indicators, front-panel lamps, and the control knob are functional.

1. From the service mode steady state, select menu item 2 by rotating the knob until “2” appears in the SpO_2% display. Press the UPPER ALARM LIMIT button. All indicators light.

2. Rotate the knob CW to light each display segment, decimal, indicator, and blip bar in a scanning pattern to verify that each lamp works.

   Note: The POWER-ON indicator is not tested with this procedure. It can be verified by turning the monitor on and off. The BATTERY CHARGING indicator is also not tested.

3. Rotate the knob CCW to reverse the firefly pattern. Knob functionality is verified by the even movement through the firefly pattern as the knob is turned.

4. Press the LOWER ALARM LIMIT button to return to the service mode steady state.

4.3.3 Menu Item 3: Button Test

This test verifies proper operation of individual buttons and button combinations.

1. From the service mode steady state, select menu item 3 by rotating the knob until “3” appears in the SpO_2% display. Press the UPPER ALARM LIMIT button. A “0” appears in the HEART/PULSE RATE display.

2. Press each of the buttons and button combinations listed below. The corresponding number appears in the HEART/PULSE RATE display to indicate that these buttons and button combinations are functioning correctly.

Press the following button and/or button combinations:	**Displayed number:**
None pressed	0
Audible alarm off	1
New patient/neonatal (rear panel)	2
Upper alarm limit	3
Lower alarm limit	4
Print	5
Upper and lower alarm limits, simultaneously	6
Upper/lower limits and print, simultaneously	7
Upper limit and audible alarm off, simultaneously	8
Lower limit and audible alarm off, simultaneously	9
Any combination not listed above	10

3. Rotate the knob CW or CCW to return to the service mode steady state.

4.3.4 Menu Item 4: Speaker Test

This test verifies that the volume control is functional and determines whether or not there are any discontinuities or saturation conditions in the audible output.

1. From the service mode steady state, select menu item 4 by rotating the knob until “4” appears in the SpO_2% display. Press the UPPER ALARM LIMIT button. A “1” appears in the HEART/PULSE RATE display and a low-level audible tone heard.

2. Rotate the control knob CW. As the number in the HEART/PULSE RATE display increases from 0 to 254, the volume will correspondingly increase.

3. Rotate the control knob CCW to decrease the volume.

4. Press the LOWER ALARM LIMIT button to return to the service mode steady state.

4.3.5 Menu Item 5: Internal Configuration Code (ICC) Report

This menu item verifies whether the current monitor configuration is the desired configuration. The ICC is the hexadecimal representation of the instrument hardware configuration derived by the UIF processor through internal examination of the modules and software present in the N-3000.

1. From the service mode steady state, select menu item 5 by rotating the knob until “5” appears in the SpO_2% display. Press the UPPER ALARM LIMIT button. The ICC value appears as the two left-most digits in the HEART/PULSE RATE display. The right-most digit displays “H” (for hexadecimal). The monitor’s configuration is represented by one of the following values:

ICC Value	Monitor Configuration
3	SpO_2 only, with serial port
7	SpO_2 and ECG only, with serial port
F	SpO_2, ECG and respiration, with serial port
12	SpO_2 only, with wired network interface
16	SpO_2 and ECG only, with wired network interface
1E	SpO_2, ECG and respiration, with wired network interface
FF	Invalid configuration

   If the displayed ICC value differs from the value stored in the EEPROM, then the displayed value will flash.

2. If the displayed value is flashing, press the UPPER ALARM LIMIT button to save the value as the default.

3. Press the LOWER ALARM LIMIT button to return to the service mode steady state.

4.3.6 Menu Item 6: Total Operating Hours Report

This report displays the total number of operating hours logged by the unit since it was produced.

1. From the service mode steady state, select menu item 6 by rotating the knob until “6” appears in the SpO_2% display. Press the UPPER ALARM LIMIT button. The total number of operating hours is displayed in the SpO_2% and HEART/PULSE RATE displays. Possible values are from 0 to 999,999 hours.

2. Press the LOWER ALARM LIMIT button to return to the service mode steady state.

4.3.7 Menu Items 7-16: Error Log Record Report

This report provides information regarding the last ten error codes recorded by the monitor, the number of occurrences of that particular error, and the number of operating hours at the last time the error occurred. The error log has ten entries (menu items 7-16), as indicated below. Refer to Section 5, *Troubleshooting*, and the Appendix for an explanation of error codes.

The following procedure is for Error Log Record 1 (menu item 7). Use the same procedure to access Error Log Records 2 through 10 (menu items 8 through 16).

1. From the service mode steady state, select menu item 7 by rotating the knob until “7” appears in the SpO_2% display. Press the UPPER ALARM LIMIT button. The number “7.0” appears in the SpO_2% display.

2. Read the error code in the HEART/PULSE RATE display. A value of “000” indicates that the menu item contains no error code. If dashes are displayed, the error log contents cannot be determined.

3. Rotate the control knob CW to display “7.1” in the SpO_2% display.

4. Read the number of occurrences of this particular error code in the HEART/PULSE RATE display. If “256” is displayed, there have been 256 or more occurrences.

5. Continue to rotate the control knob CW. The total number of operating hours when the last instance of the error occurred is displayed in the SpO_2% and HEART/PULSE RATE displays.

6. Press the LOWER ALARM LIMIT button to return to the service mode steady state.

4.3.8 Menu Item 17: Instrument Identification (IID) Report

This report displays a hexadecimal number corresponding to the instrument identifier. This number should agree with the address label on the outside of the instrument. However, the label and the internal value may disagree if the monitor UIF module was replaced and the external label was not changed.

1. From the service mode steady state, select menu item 17 by rotating the knob until “17” appears in the SpO_2% display. Press the UPPER ALARM LIMIT button. A hexadecimal number appears across the entire monitor display, with an “H” in the last (far right) position.

2. Verify that this number agrees with the number on the monitor external label. If the number does not agree, the number on the external label should be changed to agree with the displayed number.

3. Press the LOWER ALARM LIMIT button to return to the service mode steady state.

4.3.9 Menu Item 18: Power Status

This test allows you to determine battery conditions.

1. From the service mode steady state, select menu item 18 by rotating the knob until "18" appears in the SpO_2% display. Press the UPPER ALARM LIMIT button. The number "18.0" appears in the SpO_2% display. The number shown in the HEART/PULSE RATE display is the lead-acid battery voltage to the nearest tenth of a volt.

2. Rotate the control knob CW until "18.1" appears in the SpO_2% display. The number shown in the HEART/PULSE RATE display is the charge bus voltage to the nearest tenth of a volt.

3. Rotate the control knob CW until "18.2" appears in the SpO_2% display. The number shown in the HEART/PULSE RATE display is the backup lithium battery voltage to the nearest tenth of a volt.

   Note: The control knob can be rotated until "18.3" appears in the SpO_2% display. However, the number shown in the HEART/ PULSE RATE display has no meaning and can be disregarded.

4. Press the LOWER ALARM LIMIT button to return to the service mode steady state.

4.3.10 Menu Item 19: Persistent Time Sense Report

This report allows you to determine if the internal persistent time circuit is keeping time correctly.

1. From the service mode steady state, select menu item 19 by rotating the knob until "19" appears in the SpO_2% display.

2. Press the UPPER ALARM LIMIT button. The persistent time in seconds is displayed in the SpO_2% and HEART/PULSE RATE displays. For example, "001 688" indicates that the monitor has been powered on for 1,688 seconds = 28 minutes, 8 seconds. Make a note of the displayed time.

   If the display reads "999 999" this indicates that persistent time is greater than or equal to 999,999 seconds. If dashes are displayed, the contents of the memory of the persistent time circuit are lost. This can occur when the backup lithium battery has been replaced.

3. Using a watch or other timepiece, wait 3 minutes. Subtract the first figure you noted from the figure now displayed on the N-3000. The difference should equal approximately 3 minutes (180 seconds).

4. Press the LOWER ALARM LIMIT button to return to the service mode steady state.

4.3.11 Menu Item 20: Reset to Factory Defaults

This function allows you to reset the monitor to the factory default settings (see the *Specifications* section of this manual).

From the service mode steady state, select menu item 20. As soon as you press the UPPER ALARM LIMIT button, the default settings are reset. Any preset configurable alarms are now lost. When the default settings are reset, the monitor will beep three times and automatically return to the service mode steady state. If the reset was not successful, an error code will be displayed.

4.3.12 Menu Item 21: Initial Cluster Instrument Number Report

This report displays a hexadecimal number corresponding to the initial internal stack address when the instrument is being used in a stack configuration with an address conflict. Such a conflict may occur when identical instrument types (for example, two N-3100s) are in the same stack.

1. From the service mode steady state, select menu item 21 by rotating the knob until “21” appears in the SpO_2% display. Press the UPPER ALARM LIMIT button. The two left-most digits in the HEART/PULSE RATE display are the hexadecimal representation of the cluster instrument number. “H” (for hexadecimal) is displayed as the right-most digit of the HEART/PULSE RATE display.

2. If the displayed value is different than the EEPROM value, the display will flash. Rotate the knob to adjust the cluster instrument number to the desired value.

3. Press the UPPER ALARM LIMIT button to accept the displayed value as the default value. The display stops flashing.

4. Press the LOWER ALARM LIMIT button to return to the service mode steady state.

4.3.13 Menu Item 22: Latching Alarms

This function allows you to disable or enable the latching alarm feature. The factory default setting is latching alarm disabled.

1. From the service mode steady state, select menu item 22 by rotating the knob until “22” appears in the SpO_2% display. Press the UPPER ALARM LIMIT button.

2. Observe the enable/disable latching alarm setting of “OFF” or “ON” in the HEART/PULSE RATE display.

   OFF = latching alarm disabled
   ON = latching alarm enabled

3. To change the enable/disable latching alarm setting, rotate the knob until the desired setting is displayed (flashing).

4. Press the UPPER ALARM LIMIT button to store the default setting.

5. Press the LOWER ALARM LIMIT button to return to the service mode steady state.

4.3.14 Menu Item 23: Enable/Disable Alarm Silence Reminder

This function allows you to disable or enable the alarm silence reminder feature. The factory default setting is alarm silence reminder enabled.

1. From the service mode steady state, select menu item 23 by rotating the knob until "23" appears in the SpO_2% display. Press the UPPER ALARM LIMIT button.

2. Observe the alarm silence reminder setting of "OFF" or "ON" in the HEART/PULSE RATE display.

   OFF = alarm silence reminder disabled
   ON = alarm silence reminder enabled

3. To change the alarm silence reminder setting, rotate the knob until the desired setting is displayed (flashing).

4. Press the UPPER ALARM LIMIT button to store the default setting.

5. Press the LOWER ALARM LIMIT button to return to the service mode steady state.

4.3.15 Menu Item 25: Dump EEPROM Data

This function allows you to dump the entire contents of the EEPROM to a serial data capture device. This data may then be transmitted to Nellcor Puritan Bennett to assist in diagnosing the condition of the instrument.

Note: The N-3000 must be operating from AC power to perform this menu item.

1. Turn the N-3000 off.

2. Connect the N-3000 to a PC through the serial port.

3. Execute your communication software application. Port settings should be set as indicated below:

Baud Rate	19,200 (or equivalent to N-3000 setting as determined by using menu item 60)
Parity	N
Data Bits	8
Stop Bits	1

4. Power-on the N-3000 and place it in the service mode steady state.

5. Select menu item 25 by rotating the knob until "25" appears in the SpO_2% display. Press the UPPER ALARM LIMIT button. "EE" will be displayed in the HEART/PULSE RATE display.

6. Press the PRINT button to transmit the contents of the EEPROM memory out of the serial port.

7. Press the LOWER ALARM LIMIT button to return to the service mode steady state.

4.3.16 Menu Item 28: Enable/Disable Battery Charge Circuit

This test allows you to turn the battery charging circuit on or off.

1. From the service mode steady state, select menu item 28 by rotating the knob until "28" appears in the SpO_2% display. Press the UPPER ALARM LIMIT button.

2. Observe the battery charging circuit setting of "OFF" or "ON" in the HEART/PULSE RATE display.

   OFF = battery charging circuit disabled
   ON = battery charging circuit enabled

3. To enable or disable the battery charge circuit, rotate the knob until the desired setting is displayed (flashing). Press the UPPER ALARM LIMIT button.

4. Press the LOWER ALARM LIMIT button to return to the service mode steady state.

4.3.17 Menu Item 29: Instrument Compatibility Report

This function allows you to determine the cause of an "instruments not compatible" error message.

1. From the service mode steady state, select menu item 29 by rotating the knob until "29" appears in the SpO_2% display. Press the UPPER ALARM LIMIT button. The number "29.0" appears in the SpO_2% display. The number in the HEART/PULSE RATE display is the sensorbus protocol version and revision number of the N-3000.

2. Rotate the knob until "29.1" appears in the SpO_2% display. Press the UPPER ALARM LIMIT button. The number in the HEART/PULSE RATE display is the multicast version and revision number of the N-3000.

3. Press the LOWER ALARM LIMIT button to return to the service mode steady state.

4.3.18 Menu Item 30: SpO_2 RCAL Report

This function allows you to check the sensor RCAL value readings.

1. Connect the SRC-2 tester or a compatible sensor to the N-3000.

2. Select menu item 30 by rotating the knob until "30" appears in the SpO_2% display. Press the UPPER ALARM LIMIT button.

3. Read the RCAL standard representation of the nominal sensor resistance in the HEART/PULSE RATE display.

4. If connected to an SRC-2 tester, set the SRC-2 RCAL/Mode switch to 63. The RCAL value "63" is displayed in the HEART/PULSE RATE display. Set the SRC-2 RCAL/Mode switch to 64. The RCAL value "64" is displayed in the HEART/PULSE RATE display.

5. Press the LOWER ALARM LIMIT button to return to the service mode steady state.

4.3.19 Menu Item 31: SpO_2 IR and Red Offset Report

This function allows you to validate the operation of the SpO_2 module. The values represent the DC voltage offset for the current amplifier gain when the amplifier inputs are zeroed. It is not necessary to use this feature unless instructed to do so by Nellcor Puritan Bennett service personnel.

1. Connect the sensor cable and SRC-2 to the N-3000.

2. Set the SRC-2 as follows:

SWITCH	**POSITION**
RATE	38
LIGHT	LOW
MODULATION	OFF
RCAL/MODE	RCAL 63/LOCAL

3. From the service mode steady state, select menu item 31 by rotating the knob until “31” appears in the SpO_2% display. Press the UPPER ALARM LIMIT button. The SpO_2 IR offset appears in the SpO_2% display, and the SpO_2 red offset appears in the HEART/PULSE RATE display. The values are displayed in millivolts.

4. Press the LOWER ALARM LIMIT button to return to the service mode steady state.

4.3.20 Menu Item 32: SpO_2 Corrected IR and Red Signals Report

This function allows you to validate the operation of the SpO_2 module. The values represent the outputs of the IR and red sensor channels after the amplifier offset values have been applied.

1. Connect the sensor to the N-3000.

2. Verify that the SpO_2 module is set for automatic operation using menu item 39 (paragraph 4.3.27).

3. Press the LOWER ALARM LIMIT button to return to the service mode steady state.

4. From the service mode steady state, select menu item 32 by rotating the knob until “32” appears in the SpO_2% display. Press the UPPER ALARM LIMIT button. The SpO_2 corrected IR output signal is displayed in the SpO_2% display in hundredths of volts. The SpO_2 corrected red output signal is displayed in the HEART/PULSE RATE display in hundredths of volts.

5. Press the LOWER ALARM LIMIT button to return to the service mode steady state.

4.3.21 Menu Item 33: SpO_2 IR LED Drive Test

This function allows you to validate sensors and/or the operation of the SpO_2 module. It is not necessary to use this feature unless instructed to do so by Nellcor Puritan Bennett service personnel.

1. Connect the sensor to the N-3000.

2. Verify that the SpO_2 module is set for automatic operation using menu item 39 (paragraph 4.3.27).

3. Press the LOWER ALARM LIMIT button to return to the service mode steady state.

4. From the service mode steady state, select menu item 33 by rotating the knob until “33” appears in the SpO_2% display. Press the UPPER ALARM LIMIT button.

5. The SpO_2 IR drive value (between 0-255) is displayed in the HEART/PULSE RATE display.

6. To adjust the drive value, rotate the knob. The HEART/PULSE RATE display will flash. Pressing the UPPER ALARM LIMIT button will set the displayed value in the SpO_2 module, which will cease its automatic operation. The HEART/PULSE RATE display will stop flashing.

7. Press and hold the PRINT button to display the SpO_2 corrected IR and red output signals as described in menu item 32. Release the PRINT button.

8. Press the LOWER ALARM LIMIT button to return to the service mode steady state.

4.3.22 Menu Item 34: SpO_2 Red LED Drive Test

This function allows you to validate sensors and/or the operation of the SpO_2 module. It is not necessary to use this feature unless instructed to do so by Nellcor Puritan Bennett service personnel.

1. Connect the sensor to the N-3000.

2. Verify that the SpO_2 module is set for automatic operation using menu item 39 (paragraph 4.3.27).

3. Press the LOWER ALARM LIMIT button to return to the service mode steady state.

4. From the service mode steady state, select menu item 34 by rotating the knob until “34” appears in the SpO_2% display. Press the UPPER ALARM LIMIT button.

5. The SpO_2 red LED drive value (between 0-255) is displayed in the HEART/PULSE RATE display.

6. To adjust the drive value, rotate the knob. The HEART/PULSE RATE display will flash. Pressing the UPPER ALARM LIMIT button will set the displayed value in the SpO_2 module, which will cease its automatic operation. The HEART/PULSE RATE display will stop flashing.

7. Press and hold the PRINT button to display the SpO_2 corrected IR and red output signals as described in menu item 32. Release the PRINT button.

8. Press the LOWER ALARM LIMIT button to return to the service mode steady state.

4.3.23 Menu Item 35: SpO_2 DM-Gain Test

This function allows you to validate sensors and/or the operation of the SpO_2 module.

1. Connect the sensor to the N-3000.
2. Verify that the SpO_2 module is set for automatic operation using menu item 39 (paragraph 4.3.27).
3. Press the LOWER ALARM LIMIT button to return to the service mode steady state.
4. From the service mode steady state, select menu item 35 by rotating the knob until “35” appears in the SpO_2% display. Press the UPPER ALARM LIMIT button.
5. The SpO_2 demodulator gain value (from 0 to 6) is displayed in the HEART/PULSE RATE display.
6. To adjust the gain, rotate the knob. The HEART/PULSE RATE display will flash. Pressing the UPPER ALARM LIMIT button will set the displayed value in the SpO_2 module, which will cease its automatic operation. The HEART/PULSE RATE display will stop flashing.
7. Press and hold the PRINT button to display the SpO_2 corrected IR and red output signals as described in menu item 32. Release the PRINT button.
8. Press the LOWER ALARM LIMIT button to return to the service mode steady state.

4.3.24 Menu Item 36: SpO_2 P-Gain Test

This function allows you to validate sensors and/or the operation of the SpO_2 module.

1. Connect the sensor to the N-3000.
2. Verify that the SpO_2 module is set for automatic operation using menu item 39 (paragraph 4.3.27).
3. Press the LOWER ALARM LIMIT button to return to the service mode steady state.
4. From the service mode steady state, select menu item 36 by rotating the knob until “36” appears in the SpO_2% display. Press the UPPER ALARM LIMIT button.
5. The SpO_2 preamp gain (from 0 to 3) is displayed in the HEART/PULSE RATE display.
6. To adjust the gain value, rotate the knob. The HEART/PULSE RATE display will flash. Pressing the UPPER ALARM LIMIT button will set the displayed value in the SpO_2 module, which will cease its automatic operation. The HEART/PULSE RATE display will stop flashing.
7. Press and hold the PRINT button to display the SpO_2 corrected IR and red output signals as described in menu item 32. Release the PRINT button.

8. Press the LOWER ALARM LIMIT button to return to the service mode steady state.

4.3.25 Menu Item 37: Set SpO_2 Analog Test Mode

This function allows you to validate sensors and/or the operation of the SpO_2 module.

1. Connect the sensor to the N-3000.

2. From the service mode steady state, select menu item 37 by rotating the knob until “37” appears in the SpO_2% display. Press the UPPER ALARM LIMIT button.

3. The test mode setting of “0” (normal operation) is displayed in the HEART/PULSE RATE display. “SEr” is displayed in the AUXILIARY display and “37” is displayed in the SpO_2% digital display.

4. Rotate the knob to select other settings.

   1 = “zero” setting
   2 = “system test” setting

   If the displayed value is different from the current SpO_2 value, the display will flash.

   Pressing the UPPER ALARM LIMIT button will set the displayed value in the SpO_2 module, which will cease its automatic operation.

5. Press the LOWER ALARM LIMIT button to return to the service mode steady state.

4.3.26 Menu Item 38: SpO_2 A/D-Cal Line Test

This function allows you to verify calibration of the SpO_2 A/D converter.

1. From the service mode steady state, select menu item 38 by rotating the knob until “38” appears in the SpO_2% display. Press the UPPER ALARM LIMIT button.

2. Observe the PULSE RATE display. The possible values 0, 1, 2, or 3 indicate the following status

   “0” Indicates that both A/D converters are undergoing self-calibration, which will take approximately 3 seconds. A value of “0” after the 3-second period indicates that both converters have failed self-calibration.

   “1” Indicates that the IR A/D converter has completed self-calibration and the red A/D is still undergoing self-calibration or has failed self-calibration.

   “2” Indicates that the red A/D converter has completed self-calibration and the IR A/D is still undergoing self-calibration or has failed self-calibration.

   “3” Indicates that both converters have completed self-calibration.

3. Press the LOWER ALARM LIMIT button to return to the service mode steady state.

4.3.27 Menu Item 39: SpO_2 Enable Automatic Operation

This function allows you to enable or disable the SpO_2 module automatic operation mode.

1. Connect the sensor to the N-3000.

2. From the service mode steady state, select menu item 39 by rotating the knob until “39” appears in the SpO_2% display. Press the UPPER ALARM LIMIT button.

3. Observe the SpO_2 automatic operation setting of “OFF” or “ON” in the HEART/PULSE RATE display.

   OFF = SpO_2 module is not in automatic operation
   ON = SpO_2 module is in automatic operation

4. Rotate the knob to change the display and turn automatic operation ON or OFF. Press the UPPER ALARM LIMIT button to change the setting.

5. Press the LOWER ALARM LIMIT button to return to the service mode steady state.

4.3.28 Menu Item 40: Set ECG Lead

This function allows you to change the ECG lead setting. The power-on default setting is not changed.

1. From the service mode steady state, select menu item 40 by rotating the knob until “40” appears in the SpO_2% display. Press the UPPER ALARM LIMIT button.

2. The currently selected ECG lead is displayed in the HEART/PULSE RATE display.

   0 = OFF
   1 = lead I (LA-RA)
   2 = lead II (LL-RA)
   3 = lead III (LL-LA)

3. Rotate the knob to the desired ECG lead setting.

4. Press the LOWER ALARM LIMIT button to return to the service mode steady state.

4.3.29 Menu Item 41: Set ECG Pacer Filter

This function allows you to turn the pacer filter ON or OFF. Pacer filter “ON” causes the N-3000 to filter pacemaker generated signals so that they will not be measured in determining a patient’s heart rate. When the filter is “ON”, pacemaker signals of .1 to 2.0 milliseconds in duration with 2.0 to 700.0 millivolt amplitude are filtered out.

The power-on default setting is not changed.

1. From the service mode steady state, select menu item 40 by rotating the knob until “40” appears in the SpO_2% display. Press the UPPER ALARM LIMIT button.

2. “ON” or “OFF” is displayed in the HEART/PULSE RATE display. To change the current setting, rotate the knob until the desired setting is displayed. Press the UPPER ALARM LIMIT button to change the setting.

3. Press the LOWER ALARM LIMIT button to return to the service mode steady state.

4.3.30 Menu Item 42: Set ECG Low Frequency Filter

This function allows you to change the ECG low frequency filter for service mode testing. Selecting “ON” enables a .05 Hz, ECG channel, high-pass filter, providing better ST segment resolution. When “OFF” is selected, a 0.5 Hz filter is used.

The power-on default setting is not changed.

1. From the service mode steady state, select menu item 42 by rotating the knob until “42” appears in the SpO_2% display. Press the UPPER ALARM LIMIT button.

2. The currently selected ECG low frequency filter status is displayed in the HEART/PULSE RATE display.

   OFF = Filter is disabled (0.5 - 40 Hz bandwidth)
   ON = Filter is enabled (0.05 - 40 Hz bandwidth)

3. Rotate the knob to the desired low frequency filter setting. Press the UPPER ALARM LIMIT button to change the setting.

4. Press the LOWER ALARM LIMIT button to select the setting and return to the service mode steady state.

4.3.31 Menu Item 43: Set ECG Baseline Reset

This function allows you to control the ECG reset switch for service mode testing. The power-on default setting is not changed. It is not necessary to use this feature unless instructed to do so by Nellcor Puritan Bennett service personnel.

1. From the service mode steady state, select menu item 43 by rotating the knob until “43” appears in the SpO_2% display. Press the UPPER ALARM LIMIT button.

2. The currently selected reset position, “OFF” or “ON” is displayed in the HEART/PULSE RATE display.

3. Rotate the knob to the desired ECG reset. Press the UPPER ALARM LIMIT button to change the setting.

4. Press the LOWER ALARM LIMIT button to select the setting and return to the service mode steady state.

4.3.32 Menu Item 44: ECG POST Test Signal

This function allows you to send an internal test signal either singly or repetitively from the ECG module for service mode testing.

1. From the service mode steady state, select menu item 44 by rotating the knob until “44” appears in the SpO_2% display. Press the UPPER ALARM LIMIT button.

2. “44” is displayed in the SpO_2% display. “0” is displayed in the HEART/PULSE RATE display. Rotate the knob to display the following functions:

   0 = ECG POST-TEST line high

   1 = ECG POST-TEST line low

   2 = Lead selection is set to OFF and a 100 ms pulse is transmitted out the ECG POST-TEST line each time the UPPER ALARM LIMIT button is pressed

   3 = Lead selection is set to OFF and a 100 ms pulse is transmitted out the ECG POST-TEST line once a second

3. Press the UPPER ALARM LIMIT button to select the desired setting.

4. Press the LOWER ALARM LIMIT button to return to the service mode steady state.

4.3.33 Menu Item 45: Check ECG Cable Off Detection

This function allows you to test the ECG cable off circuitry.

1. From the service mode steady state, select menu item 45 by rotating the knob until “45” appears in the SpO_2% display. Press the UPPER ALARM LIMIT button.

2. The current ECG cable status is displayed in the HEART/PULSE RATE display.

   OFF = *cable off* is detected
   ON = no *cable off* is detected

3. Press the LOWER ALARM LIMIT button to select the setting and return to the service mode steady state.

4.3.34 Menu Item 46: Check ECG Lead Off Detection

This function allows you to test the ECG lead off circuitry.

1. From the service mode steady state, select menu item 46 by rotating the knob until “46” appears in the SpO_2% display. Press the UPPER ALARM LIMIT button.

2. The current ECG lead status is displayed in the HEART/PULSE RATE display.

   OFF = *lead off* is detected
   ON = no *lead off* is detected

3. Press the LOWER ALARM LIMIT button to select the setting and return to the service mode steady state.

4.3.35 Menu Item 47: Display ECG Output Value

This function allows you to test the ECG A/D channel.

1. From the service mode steady state, select menu item 47 by rotating the knob until "47" appears in the SpO_2% display. Press the UPPER ALARM LIMIT button. The PULSE SEARCH indicator is illuminated. The number "47.0" appears in the SpO_2% display and the HEART/PULSE RATE display flashes "ON" while the maximum, minimum, and average values for the ECG display and ECG analysis channels are captured.

2. When "ON" stops flashing, the maximum value in volts for the ECG display channel during the 1-second capture period is indicated in the HEART/PULSE RATE display.

3. Rotate the control knob CW until "47.1" appears in the SpO_2% display. The number shown in the HEART/PULSE RATE display is the average value in volts for the ECG display channel during the 1-second capture period.

4. Rotate the control knob CW until "47.2" appears in the SpO_2% display. The number shown in the HEART/PULSE RATE display is the minimum value in volts for the ECG display channel during the capture period.

5. Rotate the control knob CW until "47.3" appears in the SpO_2% display. The number shown in the HEART/PULSE RATE display is the maximum value in volts for the ECG analysis channel during the capture period.

6. Rotate the control knob CW until "47.4" appears in the SpO_2% display. The number shown in the HEART/PULSE RATE display is the average value in volts for the ECG analysis channel during the capture period.

7. Rotate the control knob CW until "47.5" appears in the SpO_2% display. The number shown in the HEART/PULSE RATE display is the minimum value in volts for the ECG analysis channel during the 1-second period.

8. Press the LOWER ALARM LIMIT button to return to the service mode steady state.

4.3.36 Menu Item 49: ECG Enable Automatic Operation

This function allows you to enable or disable the ECG module automatic operation mode. It is not necessary to use this feature unless instructed to do so by Nellcor Puritan Bennett service personnel.

1. From the service mode steady state, select menu item 49 by rotating the knob until "49" appears in the SpO_2% display. Press the UPPER ALARM LIMIT button.

2. The HEART/PULSE RATE display indicates whether or not the ECG module is in automatic operation.

   OFF = not in automatic operation
   ON = in automatic operation

3. Rotate the knob to change the setting. Press the UPPER ALARM LIMIT button to change the setting.

4. Press the LOWER ALARM LIMIT button to return to the service mode steady state.

4.3.37 Menu Item 51: Set Respiration Baseline Reset

This function allows you to control the respiration reset switch for service mode testing. The power-on default setting is not changed. It is not necessary to use this feature unless instructed to do so by Nellcor Puritan Bennett service personnel.

1. From the service mode steady state, select menu item 51 by rotating the knob until "51" appears in the SpO_2% display. Press the UPPER ALARM LIMIT button.

2. The currently selected reset position, "OFF" or "ON", is displayed in the HEART/PULSE RATE display. The normal position is "OFF".

3. Rotate the knob to the desired respiration reset. The displayed reset position will flash if it is different than a previously set value or if the ECG module is currently in automatic operation (menu item 49). Press the UPPER ALARM LIMIT button to change the setting.

4. Press the LOWER ALARM LIMIT button to select the setting and return to the service mode steady state.

4.3.38 Menu Item 53: Display Respiration Output Value

This function allows you to test the respiration A/D circuitry. It is not necessary to use this feature unless instructed to do so by Nellcor Puritan Bennett service personnel.

1. From the service mode steady state, select menu item 53 by rotating the knob until "53" appears in the SpO_2% display. Press the UPPER ALARM LIMIT button. The PULSE SEARCH indicator is illuminated. The number "53.0" appears in the SpO_2% display and the HEART/PULSE RATE display flashes "ON" while the maximum, minimum, and average values for the respiration channel and maximum and minimum values for the respiration impedance channel are captured.

2. When "ON" stops flashing, the maximum value in volts for the respiration signal during the capture period is indicated in the HEART/PULSE RATE display.

3. Rotate the control knob CW until "53.1" appears in the SpO_2% display. The number shown in the HEART/PULSE RATE display is the average value in volts for the respiration signal during the capture period.

4. Rotate the control knob CW until "53.2" appears in the SpO_2% display. The number shown in the HEART/PULSE RATE display is the minimum value in volts for the respiration signal during the capture period.

5. Rotate the control knob CW until "53.3" appears in the SpO_2% display. The number shown in the HEART/PULSE RATE display is the maximum value in volts for the respiration impedance signal during the capture period.

6. Rotate the control knob CW until “53.4” appears in the SpO_2% display. The number shown in the HEART/PULSE RATE display is the minimum value in volts for the respiration impedance signal during the capture period.

7. Press the LOWER ALARM LIMIT button to return to the service mode steady state.

4.3.39 Menu Item 54: Enable/Disable Respiration Monitoring

This function allows you to disable the respiration system for service mode testing. The setting does not affect normal mode operation. The power-on default setting is not changed. It is not necessary to use this feature unless instructed to do so by Nellcor Puritan Bennett service personnel.

1. From the service mode steady state, select menu item 54 by rotating the knob until “54” appears in the SpO_2% display. Press the UPPER ALARM LIMIT button.

2. The currently selected setting is displayed in the HEART/PULSE RATE display.

   OFF = disabled
   ON = enabled

3. Rotate the knob to the desired setting. If the displayed value is different from the current setting, it will flash.

4. Press the UPPER ALARM LIMIT button to change the setting.

5. Press the LOWER ALARM LIMIT button to return to the service mode steady state.

4.3.40 Menu Item 55: Enable/Disable Breath Pulses

This function allows you to enable or disable breath pulses from the serial port. When a setting is changed using this function, the power-on default setting is also changed.

When breath pulses are enabled, a pulse for each detected breath is sent out via the serial port DTR output.

1. From the service mode steady state, select menu item 55 by rotating the knob until “55” appears in the SpO_2% display. Press the UPPER ALARM LIMIT button.

2. The currently selected setting is displayed in the HEART/PULSE RATE display.

   OFF = disabled
   ON = enabled

3. Rotate the knob to the desired setting. If the displayed value is different from the current setting, it will flash.

4. Press the UPPER ALARM LIMIT button to change the setting and store it as the default setting.

5. Press the LOWER ALARM LIMIT button to return to the service mode steady state.

4.3.41 Menu Item 56: Respiration Enable Automatic Operation

This function allows you to enable or disable the respiration automatic operation mode. It is not necessary to use this feature unless instructed to do so by Nellcor Puritan Bennett service personnel.

1. From the service mode steady state, select menu item 56 by rotating the knob until "56" appears in the SpO_2% display. Press the UPPER ALARM LIMIT button.

2. The HEART/PULSE RATE display indicates whether or not the respiration circuit is in automatic operation.

   OFF = not in automatic operation
   ON = in automatic operation

3. Rotate the knob to view the settings. If the displayed value is different than the current setting, the display will flash.

4. Press the UPPER ALARM LIMIT button to accept the displayed value.

5. Press the LOWER ALARM LIMIT button to return to the service mode steady state.

4.3.42 Menu Item 60: Set Serial Port Baud Rate

This function allows you to set the default serial port baud rate.

1. From the service mode steady state, select menu item 60 by rotating the knob until "60" appears in the SpO_2% display. Press the UPPER ALARM LIMIT button.

2. The current baud rate, in hundreds, is displayed in the HEART/PULSE RATE display. Rotate the knob to view the settings. If the displayed value is different than the current setting, the display will flash.

   Note: When the N-3000 is connected to a PC in the RS-232 format, a baud rate above 19,200 should not be used.

3. Press the UPPER ALARM LIMIT button to store the displayed value as the default setting.

4. Press the LOWER ALARM LIMIT button to return to the service mode steady state.

4.3.43 Menu Item 61: Serial Port Loop Back Test

This test verifies that, when the N-3000 is connected to a PC through the N-3000 serial port, the serial port receive hardware is functional.

Note: The N-3000 must be operating from AC power to perform this menu item.

1. Turn the N-3000 off.

2. Connect the N-3000 to a PC through the serial port.

3. Execute your communication software application. Port settings should be set as indicated below:

Baud Rate	19200 (or as set using menu item 60)
Parity	N
Data Bits	8
Stop Bits	1

4. Turn on the N-3000 and place it in the service mode.

5. Select menu item 61 by rotating the knob until “61” appears in the SpO_2% display. “SLT” appears in the HEART/PULSE RATE display. Press the UPPER ALARM LIMIT button.

6. Type any characters on your PC keyboard and verify that the characters are echoed on the PC screen. This confirms that data received on the serial port receive line is transmitted on the transmit data line.

7. Press the LOWER ALARM LIMIT button to return to the service mode steady state.

4.3.44 Menu Item 62: Serial Port Transmit Test

This test verifies that, when the N-3000 is connected to a PC through the N-3000 serial port, the serial port transmit hardware is functional.

Note: The N-3000 must be operating from AC power to perform this menu item.

1. Perform steps 1 through 4 as indicated in paragraph 4.3.43, menu item 61.

2. Select menu item 62 by rotating the knob until “62” appears in the SpO_2% display. “STT” appears in the HEART/PULSE RATE display. Press the UPPER ALARM LIMIT button.

3. Verify that a fixed pattern of bytes (0 through 255) are repeatedly transmitted on the data line when menu item 62 is selected.

4. Press the LOWER ALARM LIMIT button to return to the service mode steady state.

Caution: Menu items 70 and above are for factory purposes only. Adjustment of menu items 70 and above by other than qualified factory personnel may cause the N-3000 to malfunction.

4.4 ALARM ACTIVE FUNCTION

The N-3000 alarm active function allows low, medium, or high priority alarms to be monitored from a remote location via the N-3000 serial port. This function allows use of a “nurse call” light. Alarm monitoring also applies to an attached, active N-3100 or N-3200. The monitoring remains active whether the monitor is operating on AC or DC power.

Pin 6 on the serial port is open when no alarms are active. Alarm activity results in pin 6 shorting to ground. The pin will remain shorted to ground as long as the alarm is sounding.

Figure 4-1: Serial Port Pin Locations

If voltage levels of ±7 volts on pin 1 are desired for remote alarm monitoring (while in RS-232 mode), short together the DSR (pin 2) and TXD (pin 3) lines of the communication cable. Once the alarm active function has been enabled during power-on, an alarm will toggle the DTR line pin 1 from a logic LOW of -7 volts to a HIGH of +7 volts. As long as the alarm is sounding, this line will remain HIGH. When the alarm is silenced, or becomes inactive, the line will return to its LOW logic level.

If a continuous 3.3 volt signal on pin 6 is desired (as when using the *Nellcor Puritan Bennett* SOC-3 adapter), change the dip switch settings on the Communications PCB as instructed in paragraph 6.5.1.

SECTION 5: TROUBLESHOOTING

5.1 Introduction
5.2 How to Use this Section
5.3 Who Should Perform Repairs
5.4 Replacement Level Supported
5.5 Obtaining Replacement Parts
5.6 Troubleshooting Guide

5.1 INTRODUCTION

This section explains how to troubleshoot the N-3000 if problems arise. Tables are supplied that list possible monitor difficulties, along with probable causes, and recommended actions to correct the difficulty.

5.2 HOW TO USE THIS SECTION

Use this section in conjunction with Section 3, *Performance Verification*, and Section 7, *Spare Parts*. To remove and replace a part you suspect is defective, follow the instructions in Section 6, *Disassembly Guide*. The circuit analysis section in the Technical Supplement offers information on how the monitor functions.

5.3 WHO SHOULD PERFORM REPAIRS

Only qualified service personnel should open the monitor housing, remove and replace components, or make adjustments. If your medical facility does not have qualified service personnel, contact Nellcor Puritan Bennett Technical Services or your local Nellcor Puritan Bennett representative.

5.4 REPLACEMENT LEVEL SUPPORTED

The replacement level supported for this product is to the printed circuit board (PCB) and major subassembly level. Once you isolate a suspected PCB, follow the procedures in Section 6, *Disassembly Guide,* to replace the PCB with a known good PCB. Check to see if the trouble symptom disappears and that the monitor passes all performance tests. If the trouble symptom persists, swap back the replacement PCB with the suspected malfunctioning PCB (the original PCB that was installed when you started troubleshooting) and continue troubleshooting as directed in this section.

5.5 OBTAINING REPLACEMENT PARTS

Nellcor Puritan Bennett Technical Services provides technical assistance information and replacement parts. To obtain replacement parts, contact Nellcor Puritan Bennett or your local Nellcor Puritan Bennett representative. Refer to parts by the part names and part numbers listed in Section 7, *Spare Parts*.

5.6 TROUBLESHOOTING GUIDE

Problems with the N-3000 are separated into the categories indicated in Table 5-1. Refer to the paragraph indicated for further troubleshooting instructions.

Note: Taking the recommended actions discussed in this section will correct the majority of problems you will encounter. However, problems not covered here can be resolved by calling Nellcor Puritan Bennett Technical Services or your local representative.

Table 5-1: Problem Categories

Problem Area	Refer to Paragraph
1. Power • No power-up on AC and/or DC • Fails power-on self-test • Powers down without apparent cause	5.6.1
2. Error Messages	5.6.2
3. Buttons/Knob • Monitor does not respond properly to buttons and/or knob	5.6.3
4. Display/Alarms • Displays do not respond properly • Alarms or other tones do not sound properly or are generated without apparent cause	5.6.4
5. Operational Performance • Displays appear to be operational, but monitor shows no readings • Suspect readings	5.6.5
6. Stacked Configuration • N-3000 operates properly when used alone but not when stacked	5.6.6
7. Serial Port • N-3000 and PC not communicating properly	5.6.7

All of the categories in Table 5-1 are discussed in the following paragraphs.

5.6.1 Power

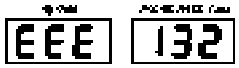
Power problems are related to AC and/or DC. Table 5-2 lists recommended actions to power problems.

Table 5-2: Power Problems

Condition	Recommended Action
1. BATTERY-IN-USE/BATTERY LOW indicator lights steadily while N-3000 is connected to AC via the external power supply.	1. Ensure that the SPS or PSS power supply is plugged into an operational AC outlet. If using the SPS power supply and the power supply indicator light is not lit, replace the power supply. If using the PSS power supply, refer to the PSS-1 technical manual. 2. Ensure that the power supply is properly plugged into the N-3000. 3. Check the fuse. The fuse is located on the lower docking connector as indicated in paragraph 6.3 and Figure 6-3 of the *Disassembly Guide* section. Replace if necessary. 4. Check the ribbon connection from the bottom enclosure to the UIF PCB, as instructed in paragraph 6.5 of the *Disassembly Guide* section. If the connection is good, replace the UIF PCB.
2. The N-3000 does not operate when disconnected from its external power supply or the power failure alarm sounds when AC power is disconnected.	1. The battery may be discharged. To recharge the battery, refer to paragraph 3.3.1, Battery Charge. The monitor may be used with a less than fully charged battery but with a corresponding decrease in operating time from that charge. 2. If the battery fails to hold a charge, replace the battery as indicated in Section 6, *Disassembly Guide*.
3. BATTERY-IN-USE/BATTERY LOW indicator flashes during DC operation.	There are 15 minutes or less of usable charge left on the N-3000 battery. At this point, if possible, cease use of the N-3000 on battery power, connect it to its external power source and allow it to recharge (approximately 14 hours). The N-3000 may continue to be used while it is recharging.
4. The microprocessor failure alarm sounds and no error code is displayed.	Replace the UIF PCB.

5.6.2 Error Codes

When there is a problem within the N-3000 monitor, an error code may be displayed on the front panel, as illustrated:



These codes correspond to messages that indicate what part of the monitor is at fault. Actions to take when encountering error codes are listed below. For a more thorough understanding of the error codes, refer to Appendix A.

5.6.2.1 User-Correctable Error Codes

The following error codes can be corrected by the operator:

Error Code	Explanation
055	Current user input values (limits, volumes, times) have been lost during an internal reset and the unit has returned to power-on defaults. Reset the values if different from power-on defaults.
058	Alarm and beep volume, audible alarm silence duration and operating mode have returned to power-on defaults due to an internal instrument reset.
062 or 063	Alarm limits have been reset to their power-on default due to software corruption in the ECG module. Press the UPPER or LOWER ALARM LIMIT button twice to display the heart rate alarm limit. This resets all limits to their power-on defaults. Turning the unit off and back on again produces the same results.
081	Cannot calibrate sensor (possible shorted/open LED or cable). Check sensor and cable connections. Check sensor and cable; replace if necessary. If replacing sensor and/or cable does not fix the problem, remove the N-3000 monitor from service. Use the SpO_2 diagnostic tests (service mode menu item numbers 31 through 39) to further evaluate the problem.

5.6.2.2 Failure Error Codes

Failure error codes are those that are displayed by the monitor with a leading digit other than “0”. In some cases, these codes can be cleared by simply turning the monitor off and then on again.

Table 5-3 lists the possible failure error codes and the recommended action to take. If the action requires replacement of a PCB, refer to Section 6, *Disassembly Guide*. If the recommended action fails to solve the problem, notify Nellcor Puritan Bennett Technical Services or your local representative. Refer to the Appendix for a further explanation of the codes.

Table 5-3: N-3000 Failure Error Codes

Error Code	Recommended Action
106	1. Turn the monitor off, then on again. 2. If the error code still appears, power-down the monitor and verify that the UIF PCB ROM (U3) is securely seated in its socket. Turn the monitor on again. 3. If the error code still appears, power down the monitor and replace the UIF PCB.
108, 109, 111, 178	1. Turn the monitor off, then on again. 2. If the error code still appears, power-down the monitor and replace the UIF PCB.
110	1. Turn the monitor off, then on again. 2. Use service mode menu item number 18 to evaluate the status of the lithium backup battery. 3. If necessary, power-down the monitor and replace the lithium backup battery. 4. If the error code still appears, power down the monitor and replace the UIF PCB.
114, 183, 283	Turn the monitor off, then on again.
151, 175, 176	1. Turn the monitor off, then on again. 2. If the error code still appears, turn off the monitor. Verify that the SpO_2 Module ROM is securely seated in the socket. 3. Verify that the SpO_2 Controller PCB is securely seated. 4. Turn the monitor on. If the error code still appears, replace the SpO_2 Controller PCB. 5. If the error code still appears, power-down the monitor and replace the UIF PCB.
159	1. Use the service mode menu item 20 to reset the default values to factory default values as discussed in Section 4, *Configuration and Service Modes.* 2. If the error code still appears, power-down the monitor and replace the UIF PCB. 3. If the error code still appears, power down the monitor and replace the SpO_2 Controller PCB.
177	1. Turn the monitor off, then on again. 2. If the error code still appears and the N-3000 is stacked with another instrument, turn all stacked instruments off and then on again.

Table 5-3: N-3000 Failure Error Codes - (Continued)

Error Code	Recommended Action
178, 191	1. Turn the monitor off, then on again. 2. If the error code still appears, use the service mode, menu item 20, to reset the default values to factory default values as discussed in Section 4, *Configuration and Service Modes*. 3. If the error code still appears, replace the UIF PCB.
179	1. Turn the monitor off, then on again. 2. If the error code is occurring while powering on after the replacement of the UIF PCB, perform the procedure in paragraph 6.10.1. If the error code still appears, verify compatibility of UIF Module SW ROM and SpO_2 Module SW ROM part numbers by using service mode menu item 17. If the error code still appears, contact Nellcor Puritan Bennett Technical Services or your local representative. 3. If the error code still appears, verify compatibility of UIF Module SW ROM and SpO_2 Module SW ROM part numbers by using service mode menu item 17. If the error code still appears, contact Nellcor Puritan Bennett Technical Services or your local representative to ensure the numbers are compatible. 4. If the numbers are compatible, power-down and verify that the SpO_2 Module ROM is securely seated. 5. Verify that the SpO_2 Controller PCB and SpO_2 module are securely seated. 6. Turn the monitor on. If the error code still appears, replace the SpO_2 Controller PCB. 7. If the error code still appears, replace the UIF PCB.
189, 376	1. Turn the monitor off, then on again. 2. If the error code still appears, replace the UIF PCB.
192, 195, 196	1. Turn the monitor off, then on again. 2. Use the service mode, menu item 29, to verify the compatibility of your software. 3. If the error code still appears, verify compatibility of the ROMs by calling Nellcor Puritan Bennett Technical Services or your local representative.
203, 206, 211	1. Turn the monitor off, then on again. 2. If the error code still appears, power-down the monitor and replace the SpO_2 Controller PCB.
204, 205	1. Turn the monitor off, then on again. 2. If the error code still appears, power-down the monitor and replace the SpO_2 PCB. 3. If the error code still appears, power down the monitor and replace the SpO_2 Controller PCB.

Table 5-3: N-3000 Failure Error Codes - (Continued)

Error Code	Recommended Action
275, 276	1. Turn the monitor off, then on again. 2. If the error code still appears, power-down and verify that the SpO_2 Controller PCB is securely seated. 3. If the error code still appears, replace the SpO_2 Controller PCB. 4. If the error code still appears, power down the monitor and replace the UIF PCB.
308, 309, 310	1. Turn the monitor off, then on again. 2. If the error code still appears, power-down the monitor and replace the ECG PCB.

5.6.3 Buttons/Knob

Table 5-4 lists symptoms of problems relating to nonresponsive buttons or the *Nellcor Puritan Bennett* knob and recommended actions. If the action requires replacement of a PCB, refer to Section 6, *Disassembly Guide*.

Table 5-4: Buttons/Knob Problems

Condition	Recommended Action
1. The N-3000 turns on but does not respond to the knob (buttons are operational).	1. If possible, verify the problem with the service mode, menu item 2, knob and lamp test. 2. Verify proper connection between knob and UIF PCB. 3. If the condition still persists, replace the UIF PCB.
2. The N-3000 responds to some, but not all buttons.	1. Verify the problem and identify faulty buttons with the service mode, menu item 3, button test. 2. If faulty buttons are AUDIBLE ALARM SILENCE button or NEW PATIENT/ NEONATAL button, replace UIF PCB. 3. If faulty buttons are on front panel, replace Display PCB. If the buttons still do not work, replace the UIF PCB.
3. The N-3000 turns on but does not respond to either the knob or any of the buttons.	1. Press the NEW PATIENT/NEONATAL button twice rapidly. If the NEONATAL MODE indicator lights, replace the Display PCB. 2. If the NEONATAL MODE indicator does not light, replace the UIF PCB.

5.6.4 Display/Alarms

Table 5-5 lists symptoms of problems relating to nonfunctioning displays, audible tones or alarms, and recommended actions. If the action requires replacement of a PCB or module, refer to Section 6, *Disassembly Guide*.

Table 5-5: Display/Alarms Problems

Condition	Recommended Action
1. Display values are missing or erratic.	1. If the sensor is connected, replace the sensor connector assembly. 2. If the condition persists, replace the sensor extension cable. 3. If the condition does not change, replace the SpO_2 PCB. 4. If the condition still persists, replace the ECG PCB. 5. If the condition still persists, replace the UIF PCB.
2. Display segments do not light.	1. Verify the problem with the service mode menu item 2, knob and lamp test. 2. Check the connection between the UIF PCB and the Display PCB. 3. If the condition does not change, replace the Display PCB. 4. If the condition still persists, replace the UIF PCB.
3. When the ECG cable is connected, there is no HEART/PULSE RATE display, but the SpO_2% display is functional.	1. Replace the cable with a known serviceable cable. 2. Ensure there is a good connection between the ECG PCB and UIF PCB. 3. If the condition still persists, replace the ECG PCB.
4. Alarm sounds for no apparent reason.	1. Moisture or spilled liquids can cause an alarm to sound. Allow the monitor to dry thoroughly before using. 2. If the condition persists, replace the UIF PCB.
5. Alarm does not sound.	1. Verify the problem with the service mode menu item 4, speaker test. 2. Replace the speaker as described in Section 6, *Disassembly Guide*. 3. If the condition persists, replace the UIF PCB.

5.6.5 Operational Performance

Table 5-6 lists symptoms of problems relating to operational performance (no error codes displayed) and recommended actions. If the action requires replacement of a PCB or module, refer to Section 6, *Disassembly Guide*.

Table 5-6: Operational Performance Problems

Condition	Recommended Action
1. The PULSE AMPLITUDE indicator seems to indicate a pulse, but the digital displays show zeroes.	1. The sensor may be damaged; replace it. 2. If the condition still persists, replace the UIF PCB.
2. SpO_2 or heart/pulse rate values change rapidly; PULSE AMPLITUDE indicator is erratic.	1. The sensor may be damp or may have been reused too many times. Replace it. 2. An electrosurgical unit (ESU) may be interfering with performance: – Move the N-3000 and its cables and sensors as far from the ESU as possible. – Plug the N-3000 power supply and the ESU into different AC circuits. – Move the ESU ground pad as close to the surgical site as possible and as far away from the sensor as possible. 3. Verify the performance with the procedures detailed in Section 3. 4. If the condition still persists, replace the UIF PCB.
3. When the ECG cable is disconnected from the leads during operation, there is no cable off alarm.	1. Replace the cable with a known serviceable cable. 2. If the condition still persists, replace the ECG PCB.
4. When the ECG leads are disconnected from the patient during operation, there is no leads off alarm.	1. Replace the cable and leads with known serviceable cable and leads. 2. If the condition still persists, replace the ECG PCB.
5. Monitor is functional for some of the ECG lead settings (I, II, or III), but not all.	1. Replace the cable and leads with known serviceable cable and leads. 2. If the condition still persists, replace the ECG PCB.

5.6.6 Stacked Operation

Table 5-7 lists symptoms of problems encountered while in the stacked configuration with the N-3100 and recommended actions. Refer to the N-3100 service manual for more troubleshooting information. For problems encountered while stacked with the N-3200, refer to the N-3200 service manual.

Table 5-7: Stack Problems

Condition	Recommended Action
1. BATTERY IN USE/BATTERY LOW indicators on the N-3000 and N-3100 light steadily while they are connected to AC via the external power supply. Both units are operational.	1. Ensure that the SPS or PSS power supply is plugged into an operational AC outlet. If using the SPS power supply and the power supply indicator light is not lit, replace the power supply. If using the PSS power supply, refer to the PSS-1 technical manual. 2. Ensure that the power supply is properly plugged into the N-3100. 3. Check the N-3000 fuse and replace if necessary.
2. BATTERY IN USE/BATTERY LOW indicators on the N-3000 and N-3200 light steadily while they are connected to AC. Both units are operational.	1. Ensure that the N-3200 power cord is plugged into an operational AC outlet and the N-3200 AC receptacle. 2. Ensure that the AC power switch on the rear panel of the N-3200 is ON. 3. Check the N-3200 fuse and replace if necessary. 4. If the condition persists, replace the N-3200 power supply as instructed in the N-3200 service manual.
3. BATTERY IN USE/BATTERY LOW indicators on the N-3000 light steadily but N-3100 and/or N-3200 does not while they are connected to AC. The units are operational.	1. Ensure that a good docking connection exists between the N-3000 and N-3100/N-3200. 2. Check the N-3000 fuse and replace it if necessary, as indicated in the *Disassembly Guide* section.
4. BATTERY IN USE/BATTERY LOW indicators on the N-3100 or N-3200 light steadily but N-3000 does not while they are connected to AC via the external power supply. Both units are operational.	1. Check the N-3100 and N-3200 fuses and replace if necessary, as indicated in the *Disassembly Guide* section of the N-3100 or N-3200 service manual.

Table 5-7: Stack Problems - (Continued)

Condition	Recommended Action
5. The N-3000 and N-3100 do not operate when disconnected from the external power supply.	1. The N-3000 battery may be discharged. To recharge the battery, keep the N-3000 connected to its external power supply. Confirm that the BATTERY CHARGING indicator lights. The monitors may be used with a less than fully charged battery but with a corresponding decrease in operating time from that charge. 2. If the battery fails to hold a charge, replace as indicated in the *Disassembly Guide* section.
6. The N-3000 and N-3200 do not operate when disconnected from AC power.	1. The N-3000 battery and N-3200 batteries may be discharged. To recharge the batteries, keep the N-3200 connected to AC power. Confirm that the BATTERY CHARGING indicator lights. The monitors may be used with a less than fully charged battery but with a corresponding decrease in operating time from that charge. 2. If the battery fails to hold a charge, replace as indicated in the *Disassembly Guide* section.
7. While operating on battery power, the N-3000 operates with BATTERY IN USE/BATTERY LOW indicator lighting steadily but N-3100 does not operate.	1. Ensure that a good docking connection exists between the N-3000 and N-3100. 2. If the condition persists, recharge the battery. The battery may have enough power left to operate the N-3000 but not the N-3100.

5.6.7 Serial Port

Table 5-8 lists symptoms of problems relating to the serial port and recommended actions. If the action requires replacement of a PCB or module, refer to Section 6, *Disassembly Guide*.

Table 5-8: Serial Port Problems

Condition	Recommended Action
1. The measured voltages at the serial port (paragraph 3.3.4.4.3) are incorrect.	1. Ensure the Communications PCB switch settings are as described in paragraph 6.5.1. 2. If the condition persists, replace the Communications PCB. 3. If the condition still persists, replace the UIF PCB.
2. The measured voltages at the serial port (paragraph 3.3.5.3) are correct but messages are not being transmitted or received.	1. Perform the serial port loop back (menu item 61) and serial port transmit (menu item 62) tests in the service mode (paragraphs 4.3.43 and 4.3.44). If the tests are successful, recheck the message formats you are sending to the monitor, ensure that a good cable connection exists between PC and N-3000, and verify the baud rate using the service mode, menu item 60. (When connected to a PC in the RS-232 format, a baud rate above 19,200 should not be used.) 2. If the test fails, ensure the Communications PCB switch settings are as described in paragraph 6.8. 3. If the condition persists, replace the Communication PCB. 4. If the condition still persists, replace the UIF PCB.

SECTION 6: DISASSEMBLY GUIDE

6.1 Introduction
6.2 Removing the Battery
6.3 Battery Replacement
6.4 Fuse Replacement
6.5 Monitor Disassembly
6.6 Removing the Alarm Speaker
6.7 Removing the SpO_2 PCB and SpO_2 Controller PCB
6.8 Removing the Communications PCB
6.9 Removing the ECG PCB and ECG Controller PCB
6.10 Removing the UIF PCB and Display PCB
6.11 Control Knob Assembly Replacement
6.12 Lithium Battery Replacement
6.13 Reassembly

6.1 INTRODUCTION

The N-3000 can be disassembled down to all major component parts, including:

- PCBs
- batteries
- cables
- function buttons
- chassis enclosures

The following tools are required:

- small, Phillips-head screwdriver
- medium, Phillips-head screwdriver
- needle-nose pliers or 1/4-inch socket
- 7/16-inch socket
- 7/16-inch torque wrench, 10 inch-pounds (1.13 newton-meters); required only when replacing knob

WARNING: Before attempting to open or disassemble the N-3000, disconnect the power cord from the N-3000.

Caution: Observe ESD (electrostatic discharge) precautions when working within the unit.

Caution: Remove the battery before disassembling the unit.

Note: Some spare parts have a business reply card attached. When you receive these spare parts, please fill out and return the card.

6.2 REMOVING THE BATTERY

Caution: If it is necessary to apply AC power while the battery cover is removed, do not connect the SPS or PSS power supply to the monitor while the power supply is plugged into AC power. Instead, first connect the power supply to the monitor, then connect the power supply to AC power. Misalignment of the power supply cord connector with the lower docking connector may result in damage to the monitor. (This caution does not apply when the battery cover is attached to the N-3000.)

Perform the following steps to replace the battery.

1. Turn the N-3000 OFF by pressing the ON/STANDBY button.

2. Disconnect the monitor from the SPS or PSS power supply.

3. Set the N-3000 upside down facing you, as shown in Figure 6-1.

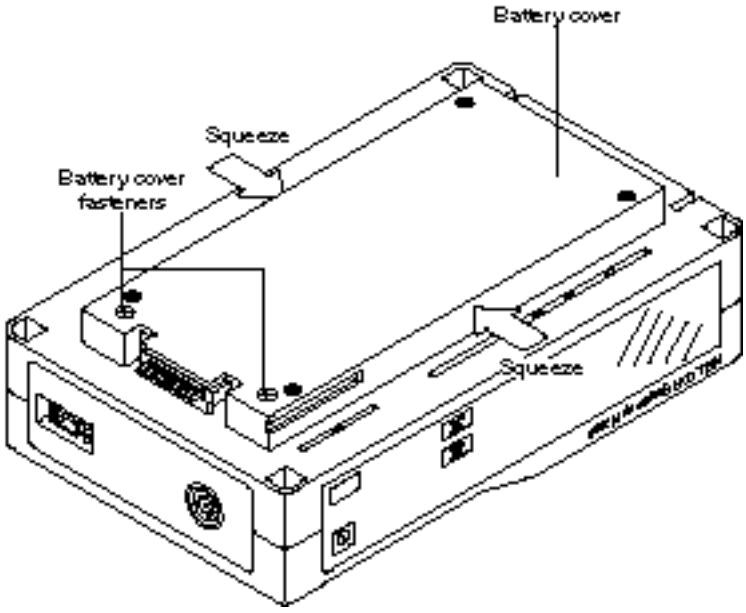


Figure 6-1: Battery Replacement

4. Loosen the two battery cover retaining fasteners securing the battery compartment cover.

5. Gently squeeze the battery cover sides in the middle as you swing the cover open (it is hinged on the right with three tabs that extend into slots on the chassis).

6. Lift the battery out of the battery bracket, as shown in Figure 6-2. It may be necessary to use the edge of a flat tip screwdriver to gently pry the battery loose.

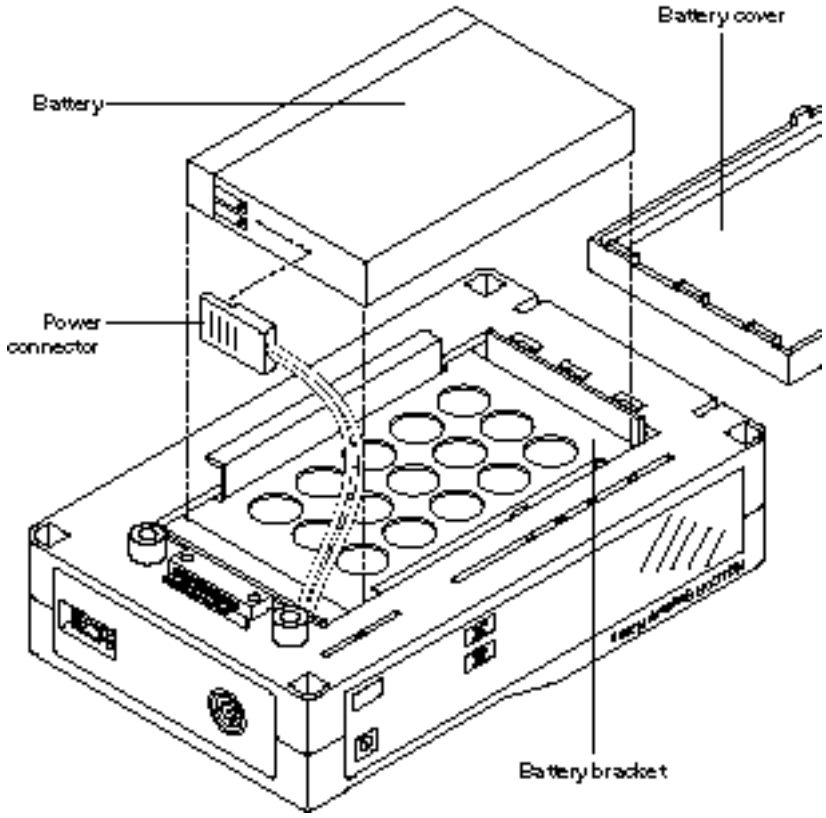


Figure 6-2: Removing the Battery

7. Disconnect the power connector from the battery.

6.3 BATTERY REPLACEMENT

1. Complete the procedure in paragraph 6.2.

2. The lead-acid battery is recyclable. Do not dispose of battery by placing it in the regular trash. Dispose of properly or return to Nellcor Puritan Bennett Technical Services for disposal.

3. Connect the power connector to the new battery.

4. Position the battery into the battery bracket.

5. Replace the battery cover and tighten the retaining fasteners.

6. Turn the monitor on and verify proper operation.

Note: If the replacement battery is low on charge, the BATTERY CHARGING indicator may not light if the monitor is off and connected to AC power. If that is the case, turn the N-3000 on to begin charging.

6.4 FUSE REPLACEMENT

1. Complete the procedure in paragraph 6.2.
2. Replace the fuses as shown in Figure 6-3 with equivalent replacements.

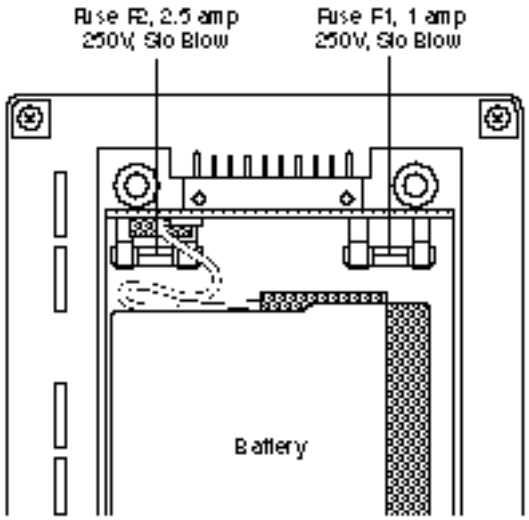


Figure 6-3: N-3000 Fuses

3. Reinstall the battery and battery cover.

Caution: The battery fuse (F2) on the Docking Connector PCB must be removed before disconnecting the docking connector cable from connector J13 as indicated in paragraph 6.5. Failure to remove the fuse may result in damage to the Lower Docking Connector PCB or UIF PCB.

6.5 MONITOR DISASSEMBLY

1. Complete the procedure in paragraph 6.2.
2. Remove the four corner screws that hold the monitor together (Figure 6-4).

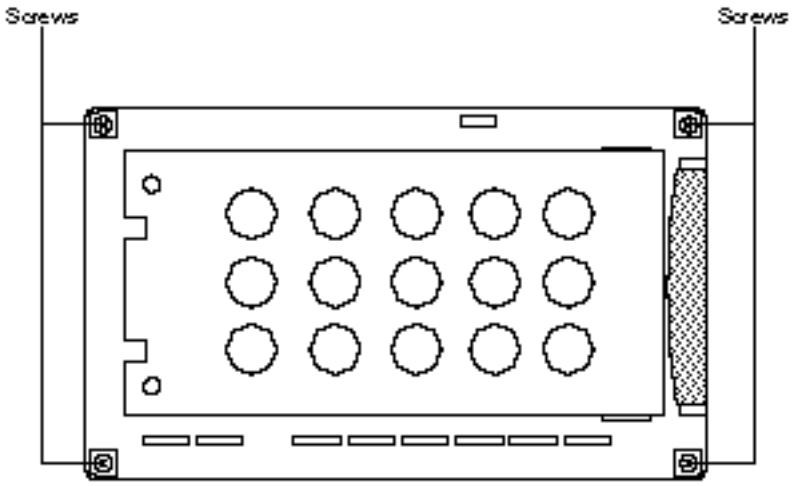


Figure 6-4: N-3000 Corner Screws

3. Pull the carrying handle down to the right.

4. Pull the unit apart, swinging the bottom half to your left, as illustrated in Figure 6-5.

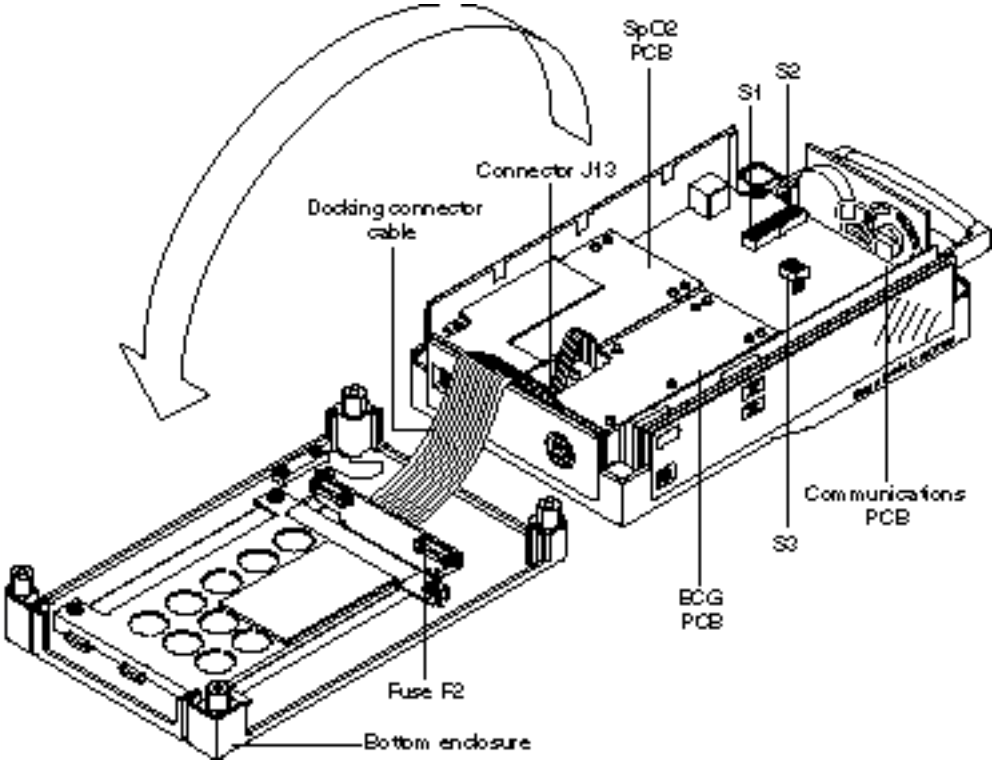


Figure 6-5: Opening the N-3000 Monitor

Caution: The battery fuse (F2) on the Docking Connector PCB must be removed as indicated in paragraph 6.4 before disconnecting the docking connector cable from connector J13. Failure to remove the fuse may result in damage to the Lower Docking Connector PCB or UIF PCB.

5. The docking connector cable is plugged into connector J13 on the UIF PCB. Disconnect the docking connector cable from connector J13 by gently pushing the top of the connector down, while pulling straight up on the cable.

6.5.1 Communications Board Switch Settings

1. To change the switch settings on the Communications PCB, complete steps 1 through 4 in paragraph 6.5.

2. The switch settings on the Communications PCB are shipped for RS-232 communications and should be as follows (refer to Figure 6-5):

   SW1 - Positions 1, 3, 5, and 7 = ON; Positions 2, 4, and 6 = OFF
   SW2 - Positions 2, 4, and 6 = ON; Positions 1, 3, 5, and 7 = OFF
   SW3 - Position 1 = ON; Position 2, 3, and 4 = OFF
   Jumper J6 in “IGND” position.

If a continuous 3.3 volt signal at pin 6 of the serial port (Figure 3.3) is required (as when using the SOC-3 adapter), change the SW3 settings as follows:

SW3 - Position 1 = OFF; Position 2, 3, and 4 = ON

If RS-422 settings are required, change SW1 and SW2 as follows:

SW1 - Positions 1, 3, 5, and 7 = OFF; Positions 2, 4, and 6 = ON
SW2 - Positions 2, 4, and 6 = OFF; Positions 1, 3, 5, and 7 = ON
SW3 - Position 1 = ON; Position 2, 3, and 4 = OFF

6.6 REMOVING THE ALARM SPEAKER

1. Complete the procedure in paragraph 6.5.

2. Remove the handle and spring assembly on the right side of the unit, as illustrated in Figure 6-6, lifting it up out of the molded chassis cradle.

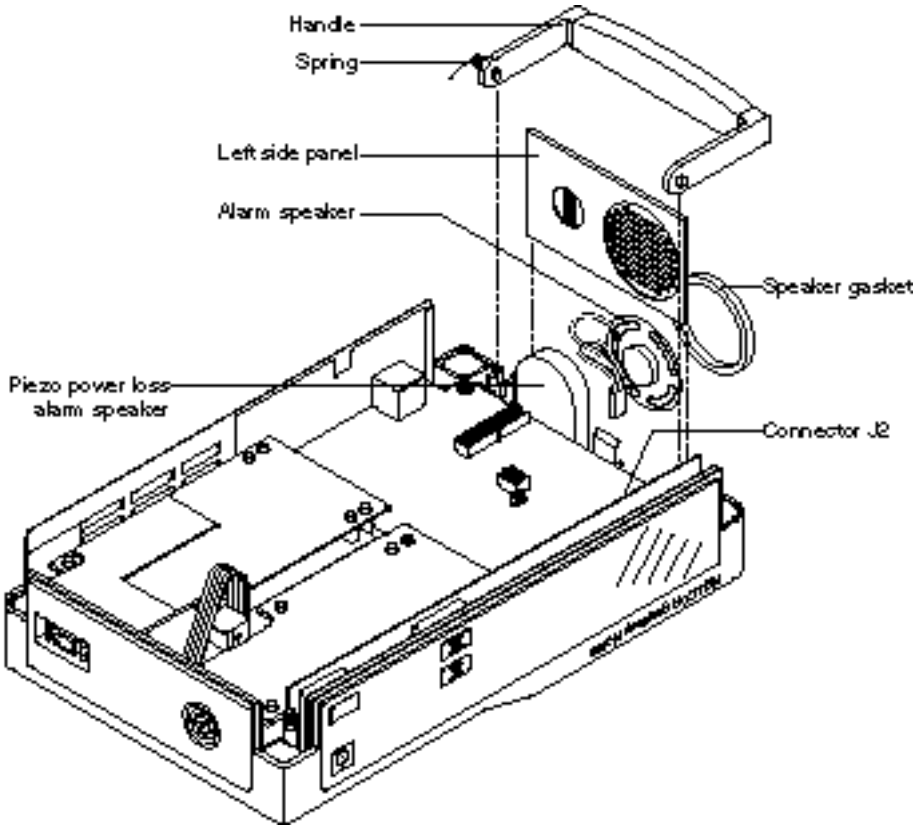


Figure 6-6: Handle, Left Side Panel, and Speaker Disassembly

3. Remove the left side panel (this is on your right, as illustrated above) by pulling straight up; be careful not to damage speakers.

4. Remove the alarm speaker cable by lifting up from connector J2 on the UIF PCB.

6.7 REMOVING THE SPO_2 PCB AND SPO_2 CONTROLLER PCB

1. Complete the procedure in paragraph 6.5.

2. Remove the rear panel, rear-panel insulator, and NEW PATIENT/NEONATAL button by lifting up and rotating out of the chassis channel guides as illustrated in Figure 6-7.

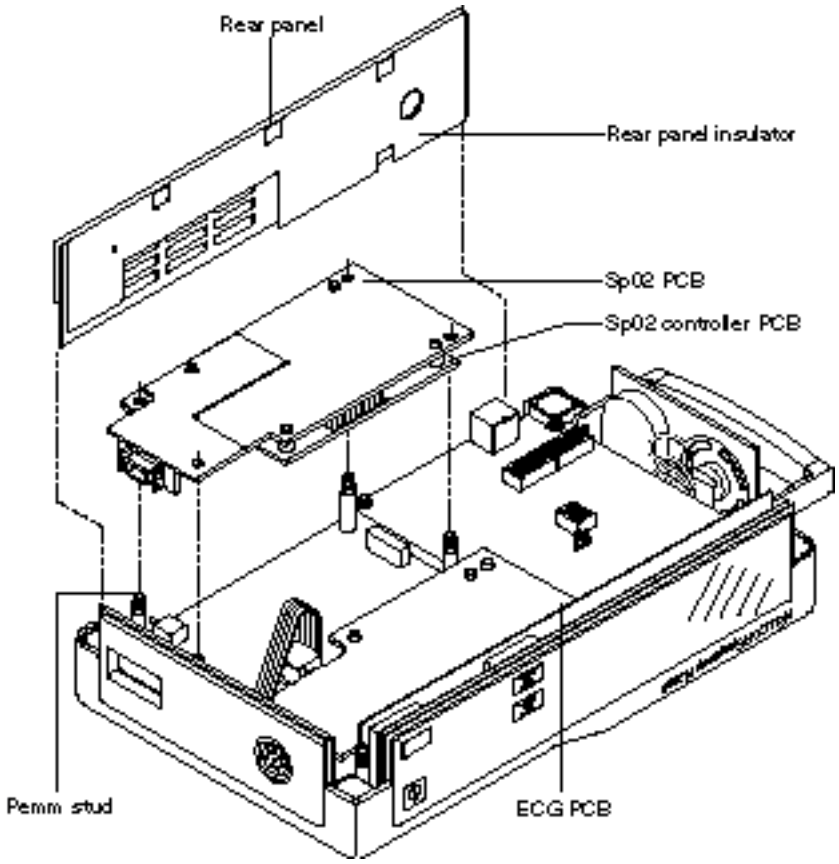


Figure 6-7: Rear Panel and SpO_2 Module Disassembly

3. Remove the SpO_2 PCB and the SpO_2 Controller PCB by disconnecting them from the Pemm studs on the UIF PCB. Pull up on the top board from the right side to disconnect from the Pemm studs.

4. To remove the SpO_2 PCB from the SpO_2 Controller PCB, unsnap the SpO_2 PCB from the Pemm studs on the SpO_2 Controller PCB.

6.8 REMOVING THE COMMUNICATIONS PCB

1. Complete the procedures in paragraph 6.6 and step 2 of paragraph 6.7.

2. Using a 1/4 inch socket or needle-nose pliers, remove the Communications PCB by removing the four 1/4-inch nuts that secure it to the UIF PCB (Figure 6-8). After removing the nuts, lift straight up.

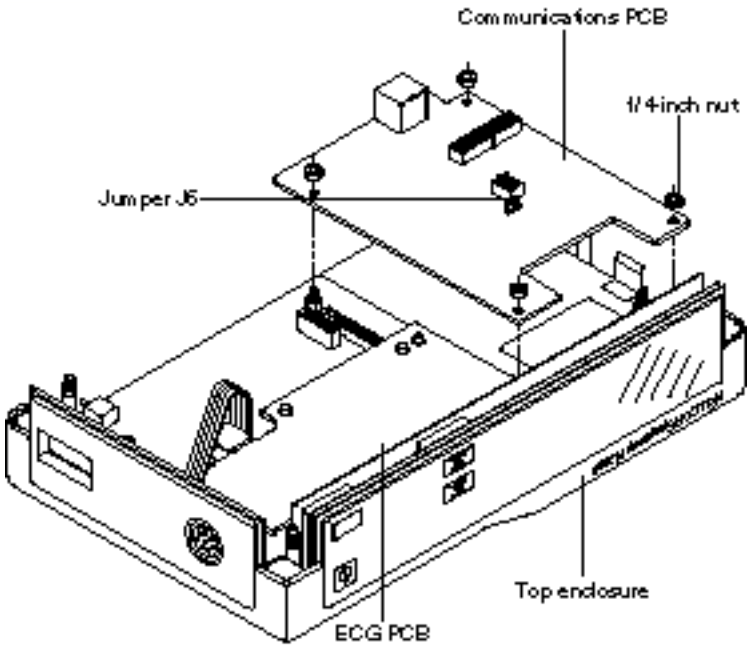


Figure 6-8: Communications PCB Removal

6.9 REMOVING THE ECG PCB AND ECG CONTROLLER PCB

Note: The ECG PCB also contains the respiration circuitry.

1. Complete the procedure in paragraph 6.5.

2. Remove the rear panel, rear-panel insulator, and NEW PATIENT/NEONATAL button by lifting up and rotating out of the chassis channel guides as illustrated in Figure 6-7.

3. Remove the ECG PCB and the ECG Controller PCB by disconnecting them from the Pemm studs on the UIF PCB. Pull up on the top board from the right side to disconnect from the Pemm studs.

4. To remove the ECG PCB from the ECG Controller PCB, unsnap the ECG PCB from the Pemm studs on the ECG Controller PCB.

6.10 REMOVING THE UIF PCB AND DISPLAY PCB

1. Complete the procedures in paragraphs 6.7, 6.8, and 6.9.

2. Remove the right-side panel by lifting it straight up.

3. Remove the front-panel bezel by gently lifting it up and rotating it away from the Display PCB as illustrated in Figure 6-9.

The display PCB is secured to the UIF PCB via the J5 connector. To remove the Display PCB, the UIF PCB must first be loosened to allow the Display PCB to be lifted out of the molded chassis housing slots.

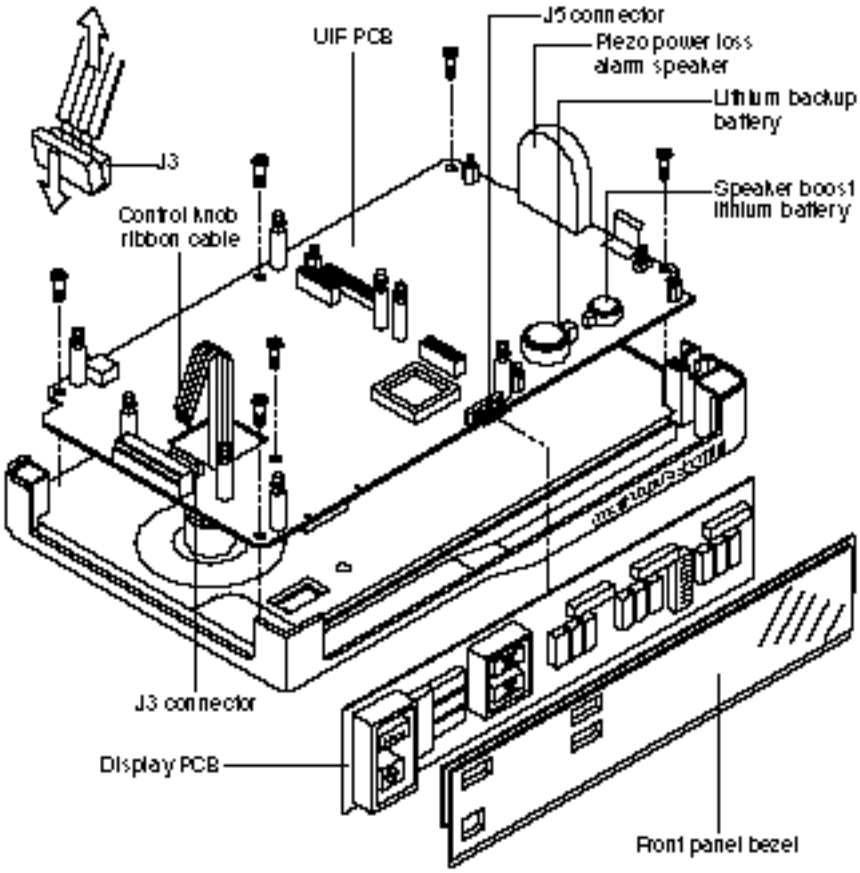


Figure 6-9: Display PCB and UIF PCB Disassembly

4. Using a Phillips-head screwdriver, remove the six screws securing the UIF PCB to the chassis.

5. Remove the Display PCB by lifting up on the mother board, then pulling the Display PCB away from the UIF PCB and disconnecting from J5.

6. Disconnect the control knob ribbon cable from J3 on the UIF PCB. Push the top of the connector down, then pull the cable straight up and out of the connector.

7. Lift the UIF PCB out of the chassis housing.

6.10.1 Installing a Replacement UIF PCB

Complete the following procedure after replacing a UIF PCB.

1. Power-up in the service mode as described in paragraph 4.3. The number “5” in the SpO_2% display indicates that menu item 5 (paragraph 4.3.5) has been accessed. The number “07” flashes in the HEART/PULSE RATE display.

2. Press the UPPER ALARM LIMIT button to accept the ICC value of “07,” indicating that the unit is an SpO_2 unit with ECG capabilities.

3. Turn the unit off. The N-3000 is ready for normal operation.

4. Replace the Instrument Identification label by attaching it to the enclosure on the bottom of the unit. Confirm the IID number using the service mode menu item 17.

6.11 CONTROL KNOB ASSEMBLY REPLACEMENT

1. Complete the procedure in paragraph 6.10. The top cover appears as illustrated in Figure 6-10.

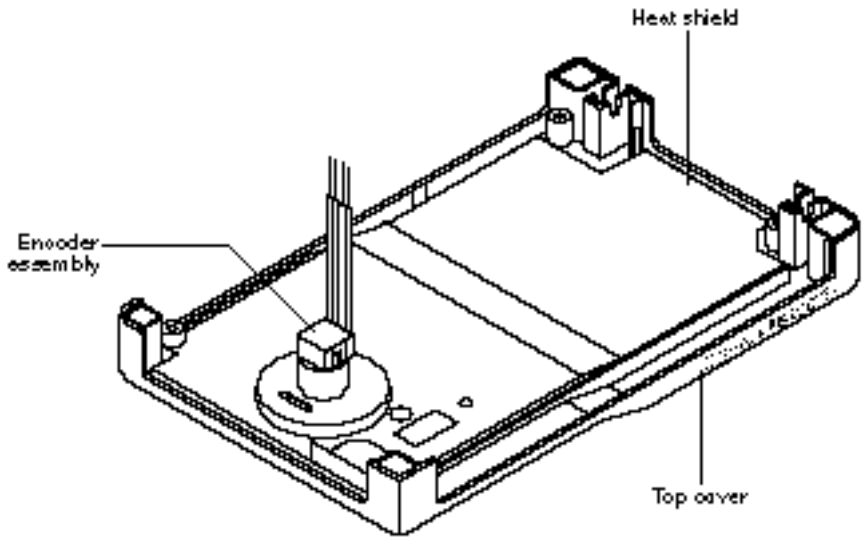


Figure 6-10: Knob Encoder Disassembly

2. Turn the cover right-side-up and use a small, flat blade to gently pry the knob off the shaft (Figure 6-11). Use caution to avoid nicking or denting the surrounding top cover.

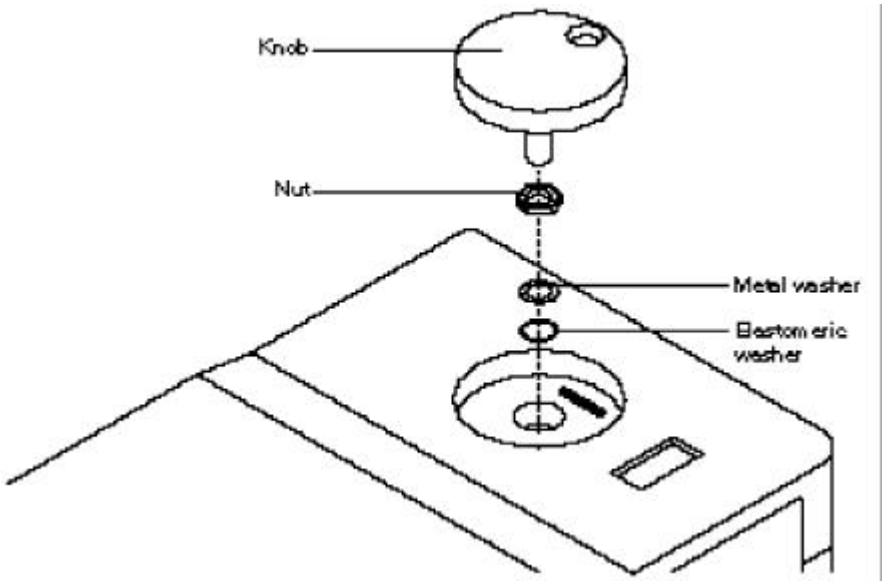


Figure 6-11: Knob Disassembly

3. Using a 7/16-inch socket, remove the nut securing the shaft and knob assembly to the chassis.

4. Replace the control knob assembly with the elastomeric washer closest to the plastic chassis. Torque nut to 10 inch-pounds. Replace the heat shield and white plastic insulator as illustrated in Figure 6-10.

6.12 LITHIUM BATTERY REPLACEMENT

1. Disconnect AC line voltage from the monitor.

2. With the monitor upside down and facing you, open up the chassis as shown in Figure 6-5.

3. Locate the lithium batteries on the UIF PCB (Figure 6-9). The backup lithium battery (the larger of the two lithium batteries) is used to supply backup power to the UIF processor if the lead-acid battery fails during DC use. It also supplies power to the piezo power loss alarm speaker during a microprocessor or power failure alarm. The other (smaller) battery provides additional voltage to power the piezo speaker.

4. Slide battery (or batteries) from underneath the spring clips. Do not dispose of lithium batteries by placing them in the regular trash. Dispose of properly or return to Nellcor Puritan Bennett Technical Services for disposal.

5. Replace batteries, observing correct polarity (positive terminal up). Ensure that they are secure.

6. Reassemble the chassis.

6.13 REASSEMBLY

Reassemble the monitor by performing the disassembly steps in reverse order.

1. Ensure that all plastic isolation shields are reinstalled correctly.

2. Ensure that the small wiper fingers that make contact with the side- panel metalized coating throughout the top chassis fit properly.

3. Ensure that all buttons are seated properly and operate smoothly.

4. All of the side panels have channel guides molded into the top and bottom chassis to assist in proper location and seating.

5. To install the handle, locate the small spring attached to one side. After all PCBs and side panels have been properly seated in the top chassis, install the handle into the cradle in a vertical position. Guide the spring into the molded channel located at the rear of the top chassis while leaning the handle to the inside of the unit. When properly seated, the handle will rotate out with a small amount of spring tension and naturally return to the vertical resting position.

6. Depending upon the level of repairs, you may have to reconfigure the monitor's Internal Configuration Code (ICC) in order to get the monitor to operate properly. Refer to the service mode section, menu item 21, of this manual.

SECTION 7: SPARE PARTS

7.1 Introduction

7.1 INTRODUCTION

Spare parts, along with part numbers, are shown below. Item numbers in parentheses correspond to the callout numbers in Figure 7-1.

Item No.	Description	Part No.
1	Cover, battery	031763
2	Battery, lead-acid, 12V-2Ah	640115
3	Bracket, battery	030487
4	Cover, bottom, monitor	031646
5	Handle, carrying	030783
6	Panel, left, speaker mount	030067
7	Gasket, speaker	032994
8	Speaker, with lead, connector and insulator	033115
9	PCB, communications, EPP	SP033961
11	Battery, lithium, small (3V, 12mm)	640112
12	Battery, lithium, large (3V, 23mm)	642002
13	PCB, ECG	SP033777
14	PCB, ECG controller	SP031802
15	Cover, top, without metal shield	024897
16	PCB, display	SP045985
18	Panel, front, lens, NA, with ECG/Resp	033309
20	Buttons, set of 2, on/standby, print, NA	030524
21	Buttons, set of 2, alarm limit	030711
22	Knob, control	024138
23	Encoder, with flexible type cable, optical	291169
25	Panel, right, with ECG, NA	033121
26	PCB, UIF	SP034971
27	PCB, SpO_2 controller	SP033274
28	Panel, rear	030065
29	PCB, SpO_2	SP030063
34	Clip, grounding	031517
35	Button, audible alarm off	031853
36	Cable, 012 CKT, docking connector	030581
37	Gasket, rubber, SpO_2	030974
38	Button, new patient/neonatal	023301
39	Insulator, ECG PCB/ECG Controller PCB, white	032974
40	PCB, docking connector	SP030221
not pictured	SPS-N1 power supply, North American	033877
not pictured	NPC-NA power cord, North American	071505
not pictured	*OXISENSOR II* assortment pack	ASP3
not pictured	Cable, EIA-232, serial interface	030604
not pictured	Cable, input, sensor	SCP10
not pictured	Fuse, 1.0A, type-T, 250V, 5x20 mm	691208
not pictured	Fuse, 2.5A, type-T, 250V, 5x20 mm	691311

Figure 7-1 shows the N-3000 expanded view with numbered callouts relating to the spare parts list.

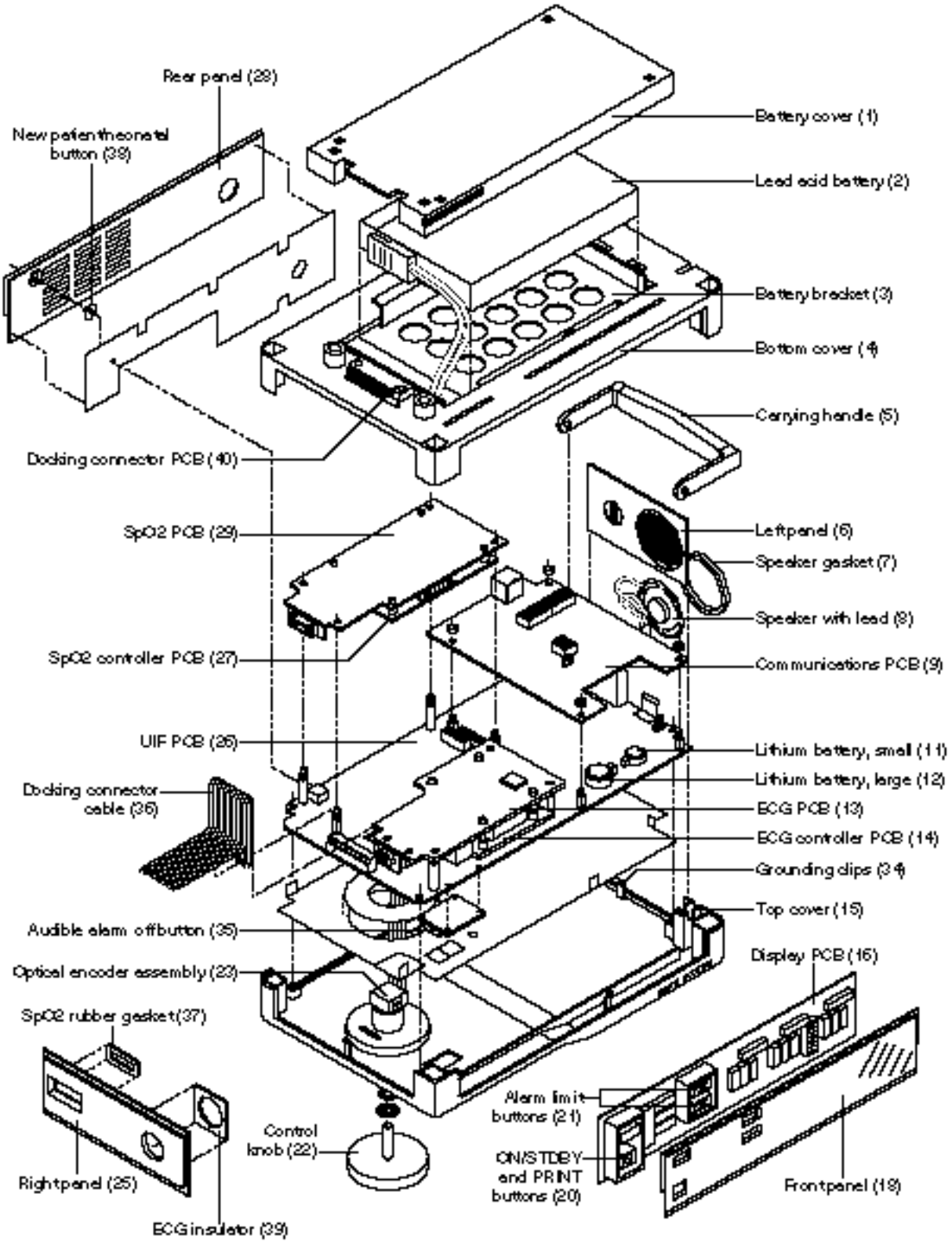


Figure 7-1: N-3000 Expanded View

SECTION 8: PACKING FOR SHIPMENT

8.1 General Instructions
8.2 Repacking in Original Carton
8.3 Repacking in a Different Carton

To ship the monitor for any reason, follow the instructions in this section.

8.1 GENERAL INSTRUCTIONS

Pack the monitor carefully. Failure to follow the instructions in this section may result in loss or damage not covered by the Nellcor Puritan Bennett warranty. If the original shipping carton is not available, use another suitable carton; North American customers may call Nellcor Puritan Bennett Technical Services to obtain a shipping carton.

Prior to shipping the monitor, contact your supplier or the local Nellcor Puritan Bennett office (Technical Services Department) for a returned goods authorization number. Mark the shipping carton and any shipping documents with the returned goods authorization number.

8.2 REPACKING IN ORIGINAL CARTON

If available, use the original carton and packing materials. Pack the monitor as follows:

1. Place the monitor and, if necessary, accessory items in original packaging.

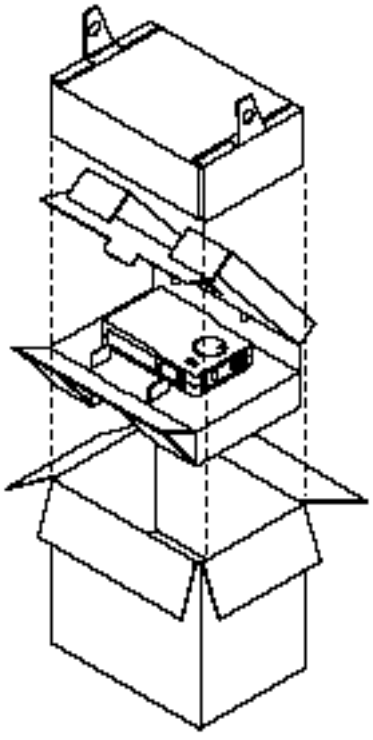


Figure 8-1: Repacking the N-3000

2. Place in shipping carton and seal carton with packaging tape.

3. Label carton with shipping address, return address and RGA number, if applicable.

8.3 REPACKING IN A DIFFERENT CARTON

If the original carton is not available, use the following procedure to pack the N-3000:

1. Place the monitor in a plastic bag.
2. Locate a corrugated cardboard shipping carton with at least 200 pounds per square inch (psi) bursting strength.
3. Fill the bottom of the carton with at least 2 inches of packing material.
4. Place the bagged unit on the layer of packing material and fill the box completely with packing material.
5. Seal the carton with packing tape.
6. Label the carton with the shipping address, return address, and RGA number, if applicable.

SECTION 9: SPECIFICATIONS

9.1 General
9.2 Electrical
9.3 Physical Characteristics
9.4 Environmental
9.5 Alarms
9.6 Factory Default Settings
9.7 Performance

9.1 GENERAL

Designed to meet safety requirements of:

UL 2601-1 CSA-C22.2 No. 601-1-M90, IEC 601-1 (Class I, type CF), ISO 9919, EMC per EN 601-1-2.

9.2 ELECTRICAL

Protection Class

Class I: per I.E.C. 601-1, clause 2.2.4

Degree of Protection

Type CF: per I.E.C. 601-1, clause 2.2.26
Defibrillation protected on ECG input port, but not SpO_2 input port

Mode of Operation

Continuous

Battery

Type	Rechargeable, sealed lead-acid, internal
Operating time	4 hours minimum on full charge when operating standalone; 2 hours minimum when attached to an N-3100 blood pressure monitor
Recharge period	14 hours for full charge; 6 hours for 1 hour of operating time
Input Voltage	15V ⎓ (DC)
Fuses	F1: 1.0 A, 250V, Slo-Blow F2: 2.5 A, 250V, Slo-Blow

External Power Supply

Model SPS-N1	AC input: 100–120 VAC, 500 mA (maximum), 50/60 Hz
Model PSS-1	AC input: 100–240 VAC, 1.3 amps, 50/60 Hz

Patient Applied Waveforms

Leads Off Sensing	DC
Active Noise Suppression	None

9.3 PHYSICAL CHARACTERISTICS

Dimensions	6.8 cm x 23.9 cm x 14.7 cm (2.65 in. x 9.41 in. x 5.79 in.)

Note: When operating without the docking pedestal (docked), the height is 5.4 cm (2.13 in.) instead of 6.8 cm (2.65 in.)

Weight	1.8 kg (3.96 lb.)

9.4 ENVIRONMENTAL

Operating Temperature	5° to 40°C (+41°F to +104°F)
Storage Temperature	-40° to +70°C (-40°F to +158°F)
Operating Altitude	-390m to +3,048m (-1,280 ft. to +10,000 ft.)
Relative Humidity	15%RH to 95%RH, noncondensing

9.5 ALARMS

Alarm Limit Range

% Saturation	20–100%
Heart/Pulse Rate	30–250 bpm
Respiration Rate	3–150 bpm

9.6 FACTORY DEFAULT SETTINGS

General Factory Default Settings

	Default Setting
Operating Mode:	Adult-Pediatric
Pulse Beep Volume:	57.5 dB(A) at 1 meter (volume setting 4)
Audible Alarm Volume:	62.5 dB(A) at 1 meter (volume setting 5)
Audible Alarm Silence Duration:	60 seconds
Alarm Silence Reminder:	ON
Latching Alarms:	OFF
Primary Heart/Pulse Source:	ECG
Pulse Beep Source	SpO_2
ECG Lead Selection:	II
ECG Pacer Filter	ON
ECG Low Frequency Filter	OFF
Trend Format:	10-second averaged (Format 1)
Serial Port Baud Rate:	19,200 bits per second
Respiration Noise Timeout:	20 seconds (adult/pediatric) 15 seconds (neonate)
Respiration Monitoring:	On

Respiration Sensitivity: 4
Breath Pulses: Off

Factory Default Alarm Settings

	Adult	Neonate
SpO_2 Upper Alarm Limit:	100%	95%
SpO_2 Lower Alarm Limit:	85%	80%
Heart/Pulse Rate Upper Alarm Limit:	170 bpm	190 bpm
Heart/Pulse Rate Lower Alarm Limit:	40 bpm	90 bpm
Respiration Rate Upper Alarm Limit:	40 breaths/min	80 breaths/min
Respiration Rate Lower Alarm Limit:	4 breaths/min	20 breaths/min

9.7 PERFORMANCE

Measurement Range

SpO_2: 0–100%

Pulse/Heart Rate: 20–250 bpm

Respiration Rate: 3–150 bpm

Alarm Characteristics

Alarm Priority	Pitch (± 30 Hz)	Pulse Width (± 20 msec)	Pulse Repetition Interval (± 20 msec)
High	932 Hz	255 msec	320 msec
Medium	752 Hz	400 msec	700 msec
Low	500 Hz	400 msec	3600 msec

Rise/fall time for pulses is 16 milliseconds ± 3 milliseconds.

Flashing Display Characteristics

During high or medium priority alarms, the .5-inch, red, front-panel display whose parameter is outside the alarm limits, flashes at the following rates:

High priority - 300 milliseconds ON, 150 milliseconds OFF
Medium priority - 750 milliseconds ON, 600 milliseconds OFF

Accuracy

SpO_2
Adult: 70–100% ± 2 digits
0–69% unspecified

Neonatal: 70–100% ± 2 digits
0–69% unspecified

Accuracies are expressed as plus or minus “X” digits (saturation percentage points) between saturations of 70-100%. This variation equals plus or minus one standard deviation (1SD), which encompasses 68% of the population. All accuracy specifications are based on testing the subject monitor on healthy adult volunteers in induced hypoxia studies across the specified range. Adult accuracy is determined with *Oxisensor II* D-25 sensors. Neonatal accuracy is determined

with *Oxisensor II* N-25 sensors. In addition, the neonatal accuracy specification is neonatal blood on oximetry measurements.

Pulse Rate (optically-derived)	20–250 bpm ± 3 bpm
Heart Rate (ECG derived)	20–250 bpm ± 5 bpm
Respiration Rate	3–150 breaths/min ± 3 breaths/min

Accuracies are expressed as plus or minus "X" bpm across the display range. This variation equals plus or minus 1SD, which encompasses 68% of the population.

ECG-Specific Performance Characteristics

Characteristic	**Value**
Resolution	1 bpm
CMRR (Common Mode Rejection Ratio)	>90 dB at 50 or 60 Hz
Frequency Response	bandwidth of 0.5 to 40 Hz +1 to -1.5 dB at 0.5 Hz +1 to -3 dB at 40 Hz
Input Impedance	2.5 megohms at 10 Hz
Defibrillator Discharge Recovery	≤ 8 seconds ≤ 5 seconds to 80% recovery
Calibration	1 millivolt reference indicator available for N-3200 ECG waveform display
Tall T-wave Rejection	Meets AAMI EC13, section 3.1.2.1 for 1.2 mV T-wave and 1 mV QRS using AAMI test waveform
Response to Irregular Rhythm (AAMI EC13, 3.1.2.1, Figure 3)	(a) Ventricular bigeminy - 80 bpm (b) Slow alternating ventricular bigeminy - 60 bpm (c) Rapid alternating ventricular bigeminy - 120 bpm (d) Bi-directional systoles - 88 to 93 bpm
Heart Rate Response Time (Change in Heart Rate from 80 bpm to 120 bpm) (Change in Heart Rate from 80 bpm to 30 bpm)	Minimum response time - 7 sec Maximum response time - 8 sec Average response time - 7.5 sec Minimum response time - 7 sec Maximum response time - 9 sec Average response time - 8 sec

Time to Alarm for Tachycardia

The following are the times to alarm for tachycardia for the test waveforms of AAMI EC13, Figure 4(a):

Ventricular Tachycardia Amplitude	**Average Time to Alarm**
0.5 mV	4 sec
1 mV	2 sec
2 mV	1 sec

The following are the times to alarm for tachycardia for the test waveforms of AAMI EC13, Figure 4(b):

Ventricular Tachycardia Amplitude	**Average Time to Alarm**
1 mV	1 sec
2 mV	2 sec
4 mV	1 sec

Pacemaker Pulse Rejection Capability

The following pacemaker pulses without over/undershoot will be rejected by the N-3000:

Pacemaker Pulse Amplitude	**Pacemaker Pulse Width**
± 2 mV	0.1 and 2.0 msec
± 700 mV	0.1 and 2.0 msec

The following pacemaker pulses with over/undershoot will be rejected by the N-3000. The over/undershoot recharge time constant is 6 milliseconds.

Pacemaker Pulse Amplitude	**Pacemaker Pulse Width**	**Over/undershoot Amplitude**
± 2 mV	0.1 msec	≤ 0.5 mV
± 2 mV	2.0 msec	≤ 0.5 mV
± 700 mV	0.1 msec	≤ 2.0 mV
± 700 mV	2.0 msec	≤ 1.5 mV

ECG Lead ID

Right arm (RA)	White
Left arm (LA)	Black
Left leg (LL)	Red

ANSI/AAMI EC 13 Standard

The N-3000 meets the ECG performance requirements of ANSI/AAMI EC 13 with the exception of clause 3.2.6.1. The N-3000 is unable to reject signals having a QRS amplitude of 1.0 millivolts and a duration of 10 milliseconds.

APPENDIX

A1 Error Types
A2 User Correctable Error Codes
A3 Failure Error Codes
A4 Internally Corrected Error Codes

A1 ERROR TYPES

There are six classes of errors that may occur during the operation of the N-3000, as indicated in Table A-1.

Table A-1: Error Types

Error Type	Description
1. Generic POST/ processor failure.	A shrill, continuous alarm may sound and the display may go blank, or nothing may happen. This represents a severe hardware failure. For example, the UIF processor could not activate the display or speaker facilities.
2. Initialization failure.	An error code representing the failure is displayed and a low-priority alarm sounds, but no entry is made in the Error Log. POST has proceeded to the point that the UIF processor controls the display and speaker facilities. The error cannot be logged because the Error Log portion of the EEPROM has failed, or internal communications to the Error Log cannot be established.
3. Failure error at the end of initialization or during steady state operation.	An EEExxx code representing the failure is displayed, a low-priority alarm sound is produced, and a “failure” class error entry is made in the Error Log.
4. Internally corrected error.	These errors do not appear on the display, or cause an alarm. They are entered in the Error Log. These errors represent events that have occurred in the instrument that are undesirable, but for which their is an effective means of recovery. This includes such things as watchdog resets, data stream restarts due to data under-run or stoppage, and resource exhaustion.
5. User-correctable error.	An EEE0xx code representing the failure is displayed and a low-priority alarm sounds, but no entry is made in the Error Log. These errors represent hardware failure conditions that can be corrected by the user, such as replacing a faulty sensor or cable. They are not logged because they are caused by equipment external to the N-3000. They are readily identified by the 0 leading digit in the error number displayed along with EEE (failure errors have a leading digit other than 0).
6. Unexpected loss of power.	This results in a shrill, pulsing alarm sound. Nothing is logged in the Error Log and the display is blank because the primary power in the instrument has failed. This alarm is powered by the secondary back-up lithium batteries located on the UIF PCB.

In all cases, an attempt to store an error in the Error Log may fail due to failure or corruption of the Error Log in EEPROM. This condition alone does not constitute a failure error and operation of the instrument proceeds as if the error has been successfully logged.

A2 USER-CORRECTABLE ERROR CODES

The error codes listed in Table A-2 are user-correctable.

Table A-2: N-3000 User-Correctable Error Codes

Error Code	Explanation
055	Current user input values (limits, volumes, times) have been lost during an internal reset and the unit has returned to power-on defaults.
058	Alarm and beep volume, audible alarm silence duration and operating mode have returned to power-on defaults due to an internal instrument reset.
062 or 063	Alarm limits have been reset to their power-on default due to software corruption in the ECG module.
081	Cannot calibrate sensor.

A3 FAILURE ERROR CODES

Table A-3 lists the possible failure error codes in numerical order.

Table A-3: N-3000 Failure Error Codes

Error Code	Explanation
106	UIF excessive watchdog resets.
108	Battery/Power management failure.
109	Stackbus gating failure.
110	Lithium battery voltage too low.
111	UIF unknown POST failure (typically, processor derail or memory corruption during POST).
114	Excessive resets (more than three in 1 minute).
151	UIF startup problem, missing resource, or unexpected state during module initialization.
159	Unable to complete operation. Institutional parameters are in unknown state.
175	UIF unable to send data over internal stack bus.
176	UIF unable to receive data over internal stack bus.
177	UIF unable to communicate with stacked instruments
178	EEPROM CRC failure (configuration EEPROM).
179	Missing or non-responding module.

183	Illegal operating mode change.

Table A-3: N-3000 Failure Error Codes - (Continued)

Error Code	Explanation
189	UIF RTC failure.
192	Duplicate node detected.
195	Incompatible software.
196	Illegal mode combination in stack.
203	SpO_2 controller failure.
204	SpO_2 digital section failure.
205	SpO_2 controller clock failure (check SpO_2 digital board clock select jumper and digital board to analog board connection).
206	SpO_2 processor clock failure.
211	SpO_2 unknown POST failure.
275	SpO_2 unable to send a command to UIF module.
276	SpO_2 PCB unable to receive data over internal stack bus.
283	Illegal operating mode change.
308	The firmware and ECG PCB do not match or the PCB board presence is not recognized. PROM on ECG board may be wrong version.
310	ECG module; ECG circuit self-test failure.
376	ECG module; Respiration circuit self-test failure.

A4 INTERNALLY CORRECTED ERROR CODES

Internally corrected error codes are not normally displayed. These errors are logged on the internal Error Log, then the N-3000 watchdog circuitry resets the monitor. They can be accessed only by using the Service Mode (menu items 7 through 16) as indicated in Paragraph 4.3, Service Mode.

Table A-4 lists the internally corrected error codes in numerical order. It is not normally necessary for service personnel to access the Error Log. However, if you find it necessary to contact Nellcor Puritan Bennett Technical Services or your local Nellcor Puritan Bennett representative, they may request information from the Error Log.

Table A-4: N-3000 Internally Corrected Error Codes

Error Code	Explanation
101	General failure of UIF Generic POST.
125	UIF cannot allocate a resource (ran out of a dynamic resource, memory corruption during initialization, or a logic error resulting from a low-probability combination of events that did not appear in unit or validation testing).

Table A-4: N-3000 Internally Corrected Error Codes - (Continued)

Error Code	Explanation
126	UIF stack overflow.
150	UIF general watchdog reset.
152	UIF memory corruption.
153	UIF unexpected interrupt.
154	UIF RTXC executive function failed.
156	UIF stack communication bus common code failed.
157	UIF state machine illegal transition or unknown state.
180	External Port Service internal error (RS232 handler).
184	UIF Data stream or Reply timeout.
225	SpO_2 can't allocate a resource.
226	SpO_2 stack overflow.
250	SpO_2 general watchdog reset.
252	SpO_2 memory corruption.
253	SpO_2 unexpected interrupt.
254	SpO_2 RTXC executive function failed.
256	SpO_2 communication bus common code failed.
257	SpO_2 state machine illegal transition or unknown state.
278	SpO_2 cannot get power-on defaults from EEPROM or they are invalid (bad values or low-limit above high-limit).
283	Operating mode changed during internal reset.
285	SpO_2 Controller PCB failure.
286	SpO_2 PCB failure.
287	SpO_2 detected failure of other system component (UIF PCB, UIF software, or communication problem).
288	SpO_2 module failure (cannot determine whether SpO_2 Controller PCB or SpO_2 PCB).

TECHNICAL SUPPLEMENT

S1 Introduction
S2 Oximetry Overview
S3 Stackbus Interconnect
S4 Circuit Analysis
S5 Schematic Diagrams

S1 INTRODUCTION

This Technical Supplement provides the reader with a discussion of oximetry principles and a more in-depth discussion of N-3000 circuits. A functional overview and detailed circuit analysis are supported by block and schematic diagrams. The schematic diagrams are located at the end of this supplement.

S2 OXIMETRY OVERVIEW

Pulse oximetry is based on two principles:

- Oxyhemoglobin and deoxyhemoglobin differ in their absorption of red and infrared light (spectrophotometry).
- The volume of arterial blood in tissue (and hence, light absorption by that blood) changes during the pulse (plethysmography).

A pulse oximeter determines SpO_2 by passing red and infrared light into an arteriolar bed and measuring changes in light absorption during the pulsatile cycle. Red and infrared low-voltage light-emitting diodes (LEDS) in the oximetry sensor serve as light sources; a photodiode serves as the photo detector.

Because oxyhemoglobin and deoxyhemoglobin differ in light absorption, the amount of red and infrared light absorbed by blood is related to hemoglobin oxygen saturation. To identify the oxygen saturation of *arterial* hemoglobin, the monitor uses the pulsatile nature of arterial flow. During systole, a new pulse of arterial blood enters the vascular bed, and blood volume and light absorption increase. During diastole, blood volume and light absorption reach their lowest point. The monitor bases its SpO_2 measurements on the difference between maximum and minimum absorption (that is, measurements at systole and diastole). By doing so, it focuses on light absorption by pulsatile arterial blood, eliminating the effects of nonpulsatile absorbers such as tissue, bone, and venous blood.

S2.1 Automatic Calibration

Because light absorption by hemoglobin is wavelength-dependent and because the mean wavelength of LEDs varies, an oximeter must know the mean wavelength of the sensor's red LED to accurately measure SpO_2. During manufacturing, a resistor in the sensor encodes the mean wavelength of the red LED. During monitoring, the instrument's software reads this resistor and selects coefficients that are appropriate for the wavelength of that sensor's red LED; these coefficients are then used to determine SpO_2. This resistor is read when the monitor is turned on, periodically thereafter, and each time a new sensor is connected.

Additionally, to compensate for differences in tissue thickness, the intensity of the sensor's LEDs is adjusted automatically.

S2.2 Functional Versus Fractional Saturation

This monitor measures functional saturation — oxygenated hemoglobin expressed as a percentage of the hemoglobin that can transport oxygen. It does not detect significant amounts of dysfunctional hemoglobin, such as carboxyhemoglobin or methemoglobin. In contrast, hemoximeters such as the IL482 report fractional saturation — oxygenated hemoglobin expressed as a percentage of all measured hemoglobin, including measured dysfunctional hemoglobins. To compare functional saturation measurements to those from an instrument that measures fractional saturation, fractional measurements must be converted as follows:

$$\text{functional saturation} = \frac{\text{fractional saturation}}{100 - (\%\,\text{carboxyhemoglobin} + \%\,\text{methemoglobin})} \times 100$$

S2.3 Measured Versus Calculated Saturation

When saturation is calculated from a blood gas partial pressure of oxygen (PO_2), the calculated value may differ from the SpO_2 measurement of a pulse oximeter. This usually occurs because the calculated saturation was not appropriately corrected for the effects of variables that shift the relationship between PO_2 and saturation (Figure S2-1): pH, temperature, the partial pressure of carbon dioxide (PCO_2), 2,3-DPG, and fetal hemoglobin.

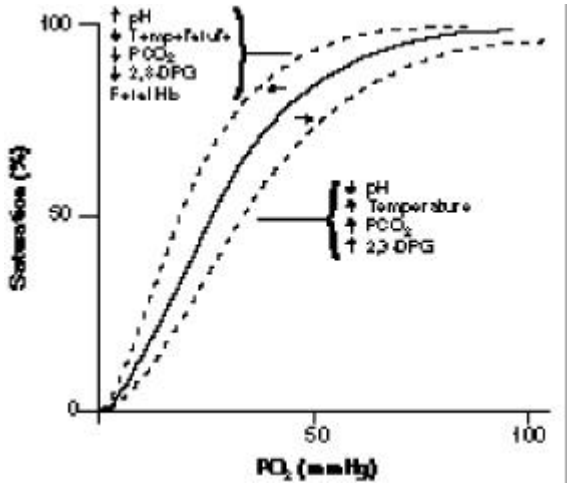


Figure S2-1: Oxyhemoglobin Dissociation Curve

S3 STACKBUS INTERCONNECT

Stackbus is the general term for the communication interconnect between the N-3000 modules and also between the N-3000, N-3100 and N-3200 instruments.

The internal stackbus is used for communications between the UIF PCB and the SpO_2 module. Information is transmitted over a single PCB trace using the Arcnet (discussed in paragraph S4, Circuit Analysis) local area network standard as the message protocol.

The external stackbus is used for communications between the N-3000, N-3100, and the N-3200. Information is exchanged over two pins on the N-3000 docking connector and two sockets on the N-3100 or N-3200 upper docking connector. As with the internal stackbus, the Arcnet local area network standard is used as the protocol.

RS-485 drivers and receivers are used for signaling. A proximity sensor in the bottom of the N-3000 or N-3100 detects when the monitor is docked, enabling the stackbus signals.

Access to the stackbus is accomplished through token passing. A token designates which station (module or instrument) has control of the stackbus. The token is passed in a circular manner from station to station. The station holding the token has the exclusive right to transmit onto the stackbus, but the right to transmit may be temporarily donated to another station to acknowledge a transmission by the token holder. The token holder must relinquish control of the stackbus by passing the token to the next station on the loop within a specified period of time. During normal operation, the right to access the stackbus passes from station to station in a continuous, consistent manner.

All instruments participate in the loop when stacked and powered-on. Maintenance of the token passing, loop initialization, lost token recovery, and the addition of new stations is implemented in the N-3000's UIF and SpO_2 modules and in the N-3100 by specialized devices and system software.

S4 CIRCUIT ANALYSIS

This section provides a descriptive overview of the N-3000 modular design, as well as a circuit description.

S4.1 Functional Overview

The monitor functional block diagram is shown in Figure S4-1. Central to the PCB modules is the UIF module. This module receives power from an external AC source or battery via the docking connector. It supplies power to the other modules connected to it, while also communicating with them via the stackbus. It controls user interface and network gateway functions.

Connected to the UIF module is the SpO_2 module, which consists of two PCBs: the SpO_2 Controller and the SpO_2 PCB. The SpO_2 Controller board contains the micro controller, memory system, internal stackbus interface, and other control logic. The SpO_2 PCB contains all the analog signal conditioning and control hardware necessary to measure SpO_2. The two boards are electrically connected by a single interface connector.

Also connected to the UIF module is the ECG module. There are two PCBs that comprise the ECG module, the ECG PCB and the ECG controller. The ECG leads from the patient are connected to this PCB where the analog ECG signals are conditioned for further processing by the ECG Controller PCB. Patient connections and initial conditioning circuits are electrically isolated from the N-3000 on this PCB. The ECG Controller PCB contains a microprocessor and supporting circuits used to supply ECG data to the UIF PCB.

The Communications module allows messages to be sent to a host computer using asynchronous serial communications. All communications signals on the Communications module originate from the UIF module.

The Display module contains annunciators and push buttons, allowing the user to access information and to select various available parameters. The Display PCB contains SpO_2 and heart rate LEDs and their associated driver circuits. Front-panel switches also allow the user to turn the unit on and off, to set alarm limits and to print data. The Display PCB is connected to the UIF module via a 14-pin connector.

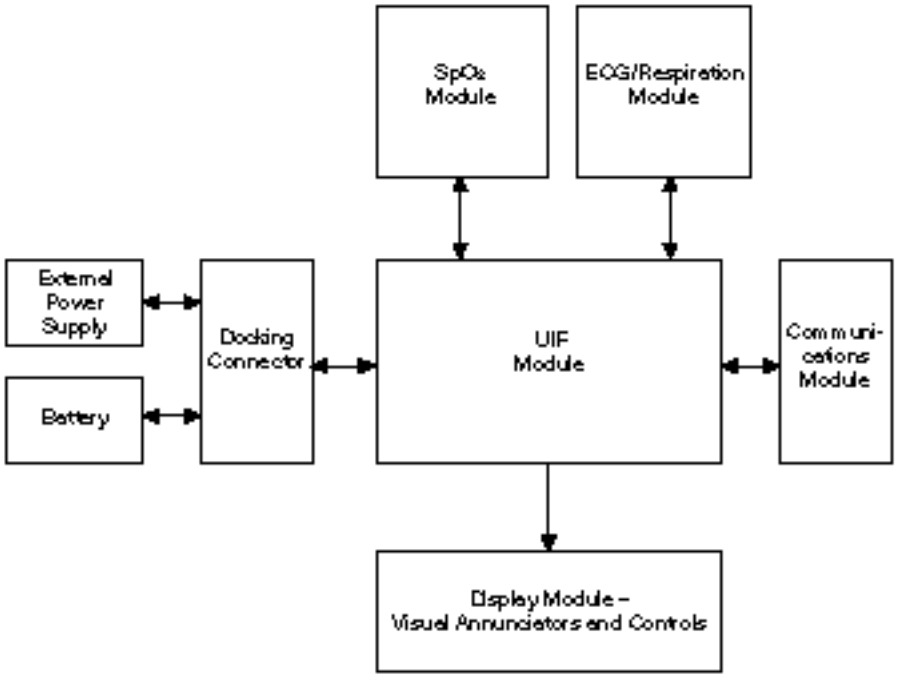


Figure S4-1: N-3000 Functional Block Diagram

S4.2 Circuit Description

The following paragraphs discuss the operation of each of the printed circuit boards within the N-3000 oximeter. (Refer to the appropriate schematic diagram at the end of this supplement, as necessary.)

S4.2.1 SpO_2 Module

a. Isolated Power Supply

Transformer T1 and associated components comprise the isolated power supply circuitry of the SpO_2 module (see sheet 1 of the schematic diagram). This power supply is a pulse-width modulated, current-mode, switching supply. In this circuitry, controller U4 is synchronized to a programmable clock frequency, ANALOG CLK (U4, pin 4). Timing for the isolated circuitry is derived from the switching frequency of the power supply, hence ANALOG CLK is used to control front-end aliasing. If no ANALOG CLK signal is available, R13 and C8 provide a default timing circuit for the U4 controller.

Two parallel FETs, Q7, drive the T1 transformer in flyback mode, channeling the current through sense resistors R23 and R133. Any inductive spike created by the leakage inductance of the T1 transformer is filtered out of the circuit by R105 and C9.

Feedback for the U4 controller is optocoupled through one-half of U34. This controls the circuit pulse width, which also maintains the isolated VCCI at 5 volts. Components R68, R69, R70, C45, and CR8 detect the value of VCCI and increase the output of the optocoupler when it (VCCI) is over 5 volts.

The transformer flyback pulse is rectified by CR7 and filtered by C12, C57, and R5 to create VCCI. The other two transformer windings have three times as many turns than the VCCI winding. These windings are rectified by CR5 and CR6 to achieve ±15 volts during the flyback cycle. These supplies are then regulated by U2 and U15 to ±12 volts.

Normal transformer signals are filtered out of the circuitry by C55, R110, CR2, Q3, R38, C14, Q6, R53, and R49. However, the Q7 turn on transition is a direct result of the ANALOG CLK signal. This creates the isolated clock signal (ISO CLK) and guarantees a consistent output pulse time independent of the pulse width modulation and inductive transient changes.

b. Timing

The ISO CLK is divided by U29 and decoded by U1 and U30 to create the timing signals used throughout the isolated section of the circuit. The timing diagram (Figure S4-2) shows the result of this decoding. One complete cycle of the front end takes 16 ISO CLK cycles.

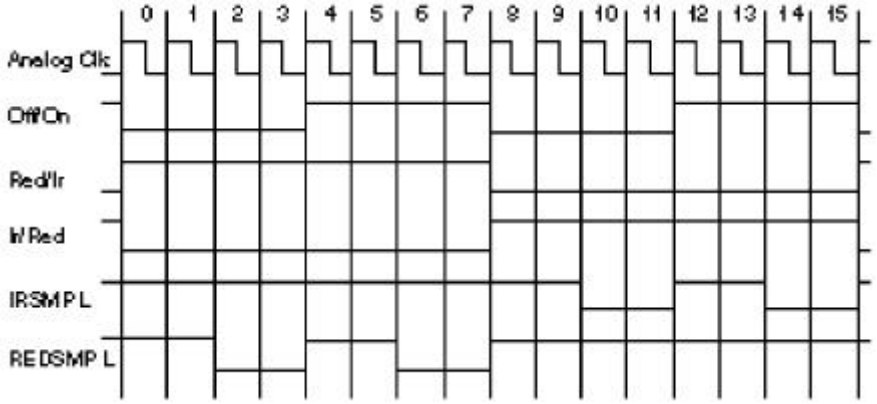


Figure S4-2: Timing Diagram

c. Microprocessor Control of Isolated Circuitry

Controller U10 (sheet 1 of schematic) is an Octal 8-bit DAC. The reference voltage for U10 is 5 volts, created by U39. Two U10 outputs, VOUTA and VOUTB, are used to program the LED outputs for the IR and RED channels. The other six signal lines are used as logic lines. Five control amplifier gain: PD0 and PD1 select the predemodulation gain, while DM0, DM1, and DM2 control the demodulated gain. The remaining signal line, CAL (U10, pin 18), selects the calibration setting.

d. LED Drive

The LED drive circuitry is shown in the lower left corner of the schematic diagram, sheet 2. Signal outputs from U10 — RED LED and IR LED — are used to control LED brightness. These signals are multiplexed by U31 and buffered by one-half of U32. A voltage divider circuit consisting of R101 and R102 divide the multiplexed signal down to the proper voltage to use as a reference for the other half of U32.

Additionally, R92 provides a path for stray current during the off period to ensure that the LEDs are truly off. Components R97, R98, and Q12 provide secondary protection against over-current drive by disabling the control op amp if the voltage goes above 0.9 volts.

Components R30 and C24 filter any high-frequency noise on VCCI that is beyond the bandwidth of U32. Finally, Q13, R104, and R105 turn the LEDs off between pulses.

e. Differential Input Amplifier

Input op amp U23 converts the differential current to a voltage. One side of the output is coupled through capacitor C48 while the other output is used as a reference that is switched by U24 onto R78 only during one channel on/off cycle. This AC couples only one channel.

Low frequency noise on the other channel is eliminated also since the LED-off output for both channels is the same. This switched AC coupling removes the DC without resulting in channel crosstalk. The resulting AC-coupled signal and reference are switched through U25 to the input of differential amplifier U21 when the patient module is plugged in.

If the cable is plugged in, U25 selects the output of the preamp and ground as the input to U21. AC coupling is performed to keep crosstalk from the preamped AC signal. Differential amplifier U21 has a programmable gain of 1, 4, 16, or 64, depending upon the state of PD0 and PD1.

f. Synchronous Demodulator and Gain

If calibration is not selected, the output of U21 is directed through U26 to filter U27 to eliminate high-frequency noise. Amplifier U28 is either an inverting or noninverting amplifier, depending on the state of switch U26.

U3 samples the output to demodulate the two channels. This sample-and-hold is then amplified by U5 or U6. The gain is 1 or 16, depending upon the state of DM2 from the U10 controller. The other half of U5 (or U6) drives the linear opto-isolator to create a current output proportional to the input voltage. This current has an effective gain of 1, 2, 4, or 8, controlled by DM0 and DM1. U13 converts the current output of the linear opto-isolator (U6) to a voltage and then to a digital value.

g. Auto Calibration

Switch U26 selects either the differential amplifier (U21) output or the internal calibration signals as an input to the U27-based filter. If the calibration input is selected, U24 can select either a zero or test input.

The zero input connects the filter input to ground so the system can calibrate the no-signal output of the two channels. The test input connects the LED current waveform to the filter so the demodulator has an output proportional to the programmed LED current.

h. Nonisolated Power Supply

The power supply creates ±5 volt from the system battery supply. The input voltage is 8–16 volts, which is filtered and regulated by U19 to create the +5 volts. U20 converts this input to a regulated -7 volt output that is regulated to -5 volts by U18.

S4.2.2 ECG/Respiration Module

The following paragraphs describe the functional areas of the ECG PCB. There are circuits on the board that are also shown on the schematic diagrams related to respiration monitoring. These circuits are not used in this model N-3000 and are not described.

a. Isolated Power Supply

DC to DC voltage converter U9 uses Vdd power referenced to chassis ground from the UIF PCB to generate positive VCCI, VDDI and VDRIVE voltages from the +VOUT output. A negative VEEI voltage is generated from the -VOUT output of U9. These power supply voltages are electrically isolated from the N-3000 chassis and are referenced to a separate isolated ground at the COM output of U9. The voltages are used to power the conditioning circuits for the ECG lead signals. Surge arrestor DT1 provides a high-voltage safety discharge path between the isolated ground and chassis ground.

b. Cable Off Detector Circuit

When the external ECG lead cable assembly is connected to the N-3000, pin 1 of connector P1 is connected to the isolated ground. This keeps the phototransistor (part of U7) shown at the top right of schematic sheet 1 turned off. If the ECG lead cable assembly is disconnected, resistor R37 causes the phototransistor to conduct and NO_CABLE line is pulled low to provide the ECG Controller with an indication that the ECG lead cable assembly is disconnected.

c. ECG Level Shift and Filtering

The ECG lead inputs are connected to the ECG PCB through external connector P1. Resistors R44, R45, R46, R47, R48, and R122 form a voltage divider to put DC voltage offsets on the left and right arm and left leg signals. These signals are then filtered and level limited before being applied to three unity gain amplifiers (parts of U1). The outputs of the unity gain amplifiers are passed through solid-state switch U2. The S0 and S1 lines, which are the isolated SEL0 and SEL1 lines from the ECG Controller, control the lead signals that are applied from the U2 DA and DB outputs to differential amplifier U4. Switch U3 is used with U2 to selectively ground the inputs to the unity gain amplifiers.

d. Lead-Off Detector Circuit

The outputs of the three unity gain amplifiers (parts of U1) are applied to a summing amplifier (another part of U1). When one or more of the ECG leads come off, the summing amplifier causes a phototransistor (part of U7) to conduct and pull the LEAD_OFF line low to provide the ECG controller with an indication that an ECG lead has come off the patient.

e. Servo Amp Circuit

The servo amp circuit provides the final conditioning of the electrically isolated ECG signal that is optically coupled to U19 to produce RAW_ECG. The output of solid-state switch U2 is connected to differential amplifier U4 which produces a combined signal from the individual ECG lead signals. The combined signal is AC coupled to an amplifier in U5 which drives part of photocoupler U8. The output of this amplifier is then applied to another amplifier in U5 which drives transistor Q2 which drives another part of photocoupler U8. The output of U8 is amplified by an amplifier in U19 the output of which is the RAW_ECG signal which is applied to the ECG lead I/II/III display and the pacemaker detection and suppression circuits.

f. ECG Lead I/II/III Display Circuit

The RAW_ECG signal from the servo amp circuit is connected to an amplifier in U19. When the ECG_REST line goes low, a 2.5 volt DC reference signal is applied through two switches in U14 to the RAW_ECG signal input to U19. The output of U19 is applied to variable-offset amplifier U13. When the GAIN1 signal from the ECG Controller is high, the gain of the servo amplifier and U19 is 4.33 dB. When the GAIN1 signal is low, the gain of U13 is 13 dB. An ECG offset voltage on the ECG_OFFSET line from U28. The value of this offset voltage is set in U28 by the ECG Controller. ECG_OFFSET is applied through amplifier U10 as the reference for U13.

The output of U13 is then applied to variable gain amplifier, part of U23. When the GAIN2 signal for the ECG Controller is high, the gain of this amplifier is 7.87 dB and when GAIN2 is high, the gain is 15.73 dB, controlled by the switch, part of U14. The output of this amplifier is ECG OUT which is applied to the ECG Controller as the ANALOG0 signal. The output of U13 is also applied to another amplifier circuit with the same variable gain composed of two amplifiers, part of U13 and part of U23. The gain of this amplifier circuit is also controlled by the switch, part of U18 by the GAIN2 signal from the ECG Controller. The output of this second variable gain amplifier is CARD OUT which is applied to the ECG Controller as the ANALOG1 signal.

g. Pacemaker Detection and Suppression Circuit

The RAW_ECG signal from the servo amp circuit is AC coupled to the pacemaker detection and suppression circuit composed of three amplifiers from U10 and inverter-buffer U17. The output of U17 is the PACER signal, which is applied to the ECG Controller as the TPU15 signal. This signal is used to reduce interference in the ECG signal caused by pacemakers.

h. Non-isolated Power Supply

Power for the non-isolated circuits on the ECG PCB is supplied on the ANALOGPWR line from the UIF PCB through the ECG Controller. The ANALOGPWR voltage is filtered to produce the V_10V operating voltage. ANALOGPWR is also applied to voltage converter U26 to produce VCC operating voltage. VCC is then used to produce VEE in converter U27 and to produce V_10M in converter U22. Voltage regulator U29 produces a 2.5 volt reference voltage from VCC.

i. Respiration Drive Circuit

U16 creates the drive signal for the respiration circuit. The 55 kHz RESP_CLOCK signal controls switching to alternately connect to the 5 volt reference or to ground. R57 and C40 isolate the precision reference, producing RESP_REF from the charge injection and transient loads produced by U16 when it switches. This circuit drops approximately 0.5 volts of the 5 volt reference. The resulting 4.5 volt squarewave is AC coupled through C39 and applied to R56, producing a proportional current into the virtual ground of U5, pin 6. This current produces the output at pin 7 of U5. The resulting voltage is multiplied by the impedance reflected through transformer T1.

The second half of U5 forms a summing junction that subtracts a portion of the drive signal from the impedance measurement, which compensates for the 8.6K ohms of resistive impedance that is on the ECG PCB and cable. This second stage also amplifies the remaining signal by 2 and helps isolate the load transients caused by the sampling circuitry from the output signal at pin 7 of U5.

j. Respiration Circuit

When enabled, U26 produces the RESP_CLOCK and RESP_SAMPLE signals are produced. RESP_CLOCK is a 55 kHz square wave and the RESP_SAMPLE signal is a normally high signal that is low for one-fourth of the 55 kHz cycle.

The RESP_SAMPLE and RAW_RESP signals are transmitted to pins 9, 10, and 11 of U3, which passes only part of the positive peaks of the RAW_RESP signal (the switch turns on when pin 9 is low). The sampled output is filtered by R91 and C52.

U25 and R90 buffer the measured impedance to isolate the load of the A/D converter. The AC and remaining DC are both present, but because the AC portion is small, this value can be used as a measurement of the total impedance for determining lead off conditions.

C50 and R82 form a high-pass filter with a 3dB frequency of 160 MHz for blocking slow variations and DC drift in the respiration signal. R118 and R119 reference the signal to a 4.01 millivolt reference which, when multiplied by the following circuit gain of 249, gives a DC value of 1.0 volt at pin 11 of U30. The output is filtered and multiplied by 2 so that the total signal gain is 996, with a nominal DC value of 2.0 volts. The gain of 2 in the filter keeps U30 in its specified input range of 0 - 2.5 volts. R64 and Q3 are used to quickly charge C50 to its operating potential when the respiration signal is enabled or when large changes in DC value occur.

S4.2.3 UIF Module

The user interface (UIF), network gateway, and battery charge functions are controlled by the UIF module. This module provides power to the other modules within the N-3000, controls communication between each module via the stackbus, and provides charge control for the lead-acid battery.

a. Power and Battery Charging

Power from the lead-acid battery or the lower docking connector is delivered via the lower docking board ribbon cable connected to J13. Pin 1 of J13 is BATTPLUS1 and Pin 6 of J13 is CHARGEBUS. Pin 2 of J13 is earth ground and Pin 5 is system ground. These pins are defined in table S4-1. Both CHARGEBUS and BATTPLUS1 are connected using diode isolation and then connected through the drain of power transistor Q10 and Pin 7 of J13 (BATTBUS) to other stacked instruments.

Power switching and battery charging are controlled by U20, a BQ2001 power monitor IC.

The BQ2001 power monitor IC has three sources of power input: CHARGEBUS from the SPS or PSS power supply, the N-3000 lead-acid battery, or lithium battery BT1. The ON/STANDBY button is connected to BQ2001, which controls the gate of power transistor Q10. Processor U3 is also connected to BQ2001, receiving interrupts and reading data from the BQ2001 status registers when the N-3000 is on.

When the N-3000 is OFF (standby mode) and the ON/STANDBY button is pressed, the BQ2001 enables transistor Q10 and analog power from either the CHARGEBUS or the lead-acid battery is supplied to the 5V regulator (U17 and U18) and the SpO_2 module. It also signals the processor with an interrupt that

there is new data in its status registers for the processor to read. As soon as the processor powers-up and clears reset, it will process the interrupt from the BQ2001 and begin to execute its program.

Table S4-1: J13 Inter Stack Connector

Pin No.	Pin Description	Input/Output/Power
1	Positive battery terminal (fused)	Power
2	Chassis (case) ground	Power
3	Stackbus differential +	I/O
4	Stackbus differential -	I/O
5	Digital ground	Power
6	Charge bus (15V)	Power
7	Battery bus voltage	Power
8	Proximity signal	Input
9	Not used	n/a
10	Not used	n/a
11	Not used	n/a
12	Battery charge	Power

When the N3000 is on and the ON/STANDBY button is pressed, the BQ2001 signals the processor via interrupt that there is data for the processor to read. When the processor reads the status, it determines that the unit should be turned off and signals the BQ2001 to disable Q10.

Other sources of interrupt from the BQ2001 are a low voltage from lithium battery BT1, the application or removal of CHARGEBUS power, and the lead-acid battery voltage falling below a threshold preset by the processor.

When the SPS or PSS power supply is connected to the lower docking connector and connected to AC, CHARGEBUS has a voltage of 15V ± 0.75V. This powers the battery charge overcurrent and overtemperature circuitry. The BQ2001 controls battery charging. When the processor senses that the battery needs charging, it tells the BQ2001 to turn on transistor Q5 for a programmed length of time. The BQ2001 will continue charging the battery as long as there is CHARGEBUS available and its internal charge time register has not expired regardless of the mode of the N3000, unless it is told to stop by the processor or it senses that the over-temperature circuit has tripped.

The battery charging circuitry is a constant voltage charger. When the battery is discharged, its output voltage is low (about 10V) and the maximum charge rate (approximately 350mA) is applied to it. As the battery charges, its output voltage rises, reducing the amount of current delivered to it by CHARGEBUS. When the battery is fully charged (about 14V), the charge rate decreases to 0 mA.

The over-temperature cutoff circuitry is physically located close to the power transistor used to charge the battery by the BQ2001. When the area around the transistor approaches 70° C, the circuit will signal the BQ2001 to stop charging. When the transistor cools, charging is resumed.

To protect the battery, a thermal cutoff switch is located on the docking connector close to the lead-acid battery compartment. When the temperature in

the battery compartment approaches 50° C, the switch opens to prevent damage to the lead-acid battery.

b. Processor

The processor for the UIF PCB is U3, a Motorola MC68331 IC. This processor uses a 32-bit CPU and contains several submodules, including pulse-width modulators, internal RAM, and a Queued Serial Module (QSM). The processor also contains a non-multiplexed, data/address bus and input/output timer pins.

The processor generates chip selects, address lines, data direction, and data strobes for communicating with its peripherals over its bi-directional, 16-bit data bus D15 through D0. The chip select outputs are /CSBOOT and /CS0 through /CS8. The address lines are A0 through A18. The data direction is generated by U3 on R/W. The data strobe for indicating valid data is generated on /DS. Using these control lines, the processor is capable of reading from or writing to any of the peripherals attached to its data bus. Data transfers are either 16-bit (D15 through D0) or 8-bit (D15 through D8).

A 32.679 kHz source clock signal for the processor is produced by stackbus adapter U14 from crystal Y3. System clock frequency is chosen by software.

c. Processor Peripheral ICs

Processor U3 uses serial and parallel peripheral ICs.

The serial peripheral ICs communicate with the processor through the 68331 Queued Serial Module (QSM). These ICs are the Real Time Clock (RTC), the Electrically Erasable Read Only Memory (EEROM) and the display controllers located on the Display PCB.

The parallel peripheral ICs communicate with the processor through a non-multiplexed data bus. The ICs are processor code PROM U10, processor RAMs U13 and U23, Arcnet communications IC U6, digital-to-analog converter U5, analog-to-digital converter U27, stackbus adapter U14, BQ2001 power management chip U20, and UART (Universal Asynchronous Receiver Transmitter) U24.

Real Time Clock Ñ The clock is a continuously running IC used by the processor to maintain time and date information. When the N-3000 is not on, the RTC is maintained by lithium backup battery BT1.

Electrically Erasable Read Only Memory Ñ The EEROM is used by the processor to store institutional defaults and system error code data.

Display Controllers Ñ These controllers are used by the processor to display data on the display board.

Processor Code PROM (U10) Ñ The PROM contains the program that the processor uses to perform the user interface and gateway functions for the N-3000. Processor U3 address lines A1 through A17 are connected to PROM addresses A0 through A16, allowing even word address access to the PROM. To allow the use of either a 256K x 16 or 128K x 16 PROM at U10, Pin 43 of U10 is connected to J10 Pin 2. On a 256K x 16 PROM, Pin 43 will be PROM address A17. On a 128K x 16 PROM, Pin 43 will be an active high output enable. Address line A18 from U3 is connected to J10 pin 1 and VDD is connected to J10 pin 3. Attaching a jumper between J10 pins 1 and 2 will connect U3 address line A18 to PROM address A17 to address all 256K words in a 256K x 16

PROM. Connecting a jumper between J10 Pins 2 and 3 will connect Pin 43 to VDD for the active hi output enable of a 128K x 16 PROM.

The PROM chip select is connected to the /CSBOOT signal (Pin 112) of U3. At system reset, this signal defaults to decode address %00000 for a block of 1 megabyte, held active for 13 wait states and gated with the processor address strobe. The output enable of the PROM (pin 22) is connected to ground through R8 to allow data to be gated onto the data bus as soon as the /CSBOOT signal goes active. After a system reset, /CSBOOT is configured to have one wait state and to be active only for the address range of the PROM.

Processor RAM (U13 and U23)Ñ The RAMs are used by the processor to store program variables, values and trend data. Each is 128K x 8, arranged to provide 128K x 16 bits of RAM for use by the processor. U3 address lines A17 through A1 are connected to both RAMs' address lines A16 through A0. U3 data bus lines D15 through D8 are connected to U13 data bus lines D7 through D0 for the upper 8 bits of data. U3 data bus lines D7 through D0 are connected to U23 data bus lines D7 through D0 for the lower 8 bits of data.

The active low chip select inputs of U13 and U23 are connected to the CS0 and CS1 chip select outputs of U3. The active high chip select inputs of U13 and U23 are connected to the active low system reset to prevent writing to the RAM while the system power is coming on or while the watchdog reset is active. The output enables of U13 and U23 are connected to digital ground. The write enable inputs of U13 and U23 are connected to the data direction (R/-W) output of U3. At system reset, the RAM chips are disabled and CS0 and CS1 from U3 are disabled. After system reset, CS0 and CS1 are configured to be gated with data strobe output DS from U3.

When the N-3000 is in STANDBY, RAM power is supplied by the backup battery output of the BQ2001. Power is maintained by the N-3000 lead-acid battery and, in the event that the lead-acid battery becomes discharged or is removed, by the lithium backup battery BT1.

Arcnet controller — U6 is the Arcnet controller (COM20020). It is used by the processor to implement the stackbus protocol. It is an 8-bit, memory-mapped device that manages the stackbus communications physical implementation along with the stackbus adapter. It is connected to the upper 8 bits of the processor data bus to allow for byte operations from the processor. The chip select for U6 is processor pin /CS4.

Digital to Analog Converter — DAC U5 is an 8-bit converter used by the processor to control speaker volume. It is a write-only, memory-mapped peripheral connected to the upper 8 bits (D15 through D8) of the processor data bus. It converts the 8-bit data value written into it by the processor to control the amplitude of the square wave generated by processor output OC2.

The resultant amplitude controlled square wave is then sent to audio amplifier U4 to drive the 8-ohm speaker. The chip select for U5 is processor pin /CS5.

Analog to Digital Converter — ADC U27 is an 8-bit analog to digital converter used by the processor to measure three different analog voltages. It is a read-only, memory-mapped peripheral connected to the upper 8 bits (D15 through D8) of the processor data bus. The analog voltage values indicate which display board button has been pressed, what the combined voltage of both lithium batteries is, and the value of the analog voltage being supplied from transistor Q10 to the SpO2 module and 5V regulator chips (U17 and U18). The chip select for U5 is processor pin /CS7. The selection of analog voltages to read is

controlled by processor outputs PWMA and PWMB which must be set up prior to accessing U27.

Stackbus Adapter — Adapter U14 is an FPGA (field programmable gate array) used by the processor to control the hub functions for both the internal and external stackbus. It also decodes the knob movement as well as providing a 32.679kHz source clock. It is an 8-bit, memory-mapped peripheral connected to the upper 8 bits (D15 through D8) of the processor data bus. The internal stackbus provides the communications for the UIF module and the SpO_2 module. The external stackbus is used to communicate with other instruments when the unit is used in the stack configuration. The chip select for U14 is processor pin /CS3.

Universal Asynchronous Receiver Transmitter — UART U24 is an industry standard 16C550. It is an 8-bit memory-mapped peripheral connected to the upper 8 bits (D15 through D8) of the processor data bus. It contains two 8-byte FIFOs, one for transmit and one for receive, a baud rate generator, and several programmable I/Os for enabling isolated power on the communications module, serial communication handshaking, and alarm active signaling. The chip select for U24 is processor Pin /CS6.

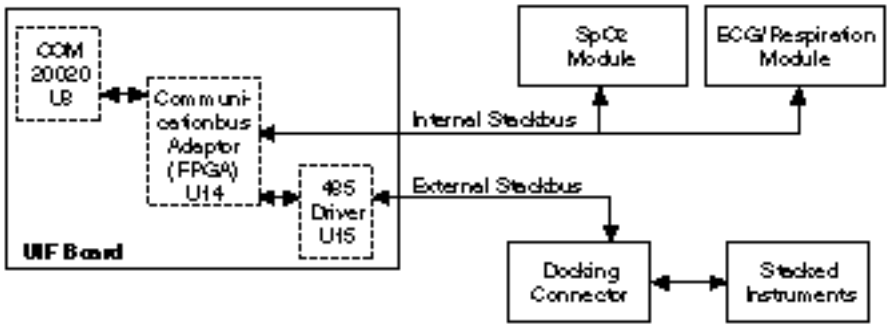


Figure S4-3: Internal/External Stackbus Connections

d. Processor Support ICs

The processor support ICs are used to monitor the processor and its power supply, resetting U3 when necessary, and to sound an alarm using piezo speaker Y1 when the processor appears to be inoperative or when the unit has had an unexpected power loss.

The processor support ICs are watchdog timer U21 and the processor/power fail circuitry consisting of U16, U1, U2, U11, U22, and U29.

Watchdog Timer — Timer U21 ensures that processor U3 does not operate and switches the backup battery power from U20 to the RAMPWR supply when the +5 volt supply is below its lower regulation limit. This chip holds U3 in reset until the power supply is above its lower regulation limit.

The watchdog timer also resets the processor if the processor input signal (CLRWD) is not toggled within a timeout period controlled by the watchdog oscillator circuitry. When the watchdog times out, it generates a signal that causes the piezo power loss alarm speaker to emit a tone. The timeout also causes the display to go blank and generates a reset to U3. The tone continues until the watchdog is cleared by:

- activity on the CLRWD signal line
- pressing the ALARM SILENCE button
- removing power from the circuit

Timer U21 also switches the backup battery power from U20 to RAMs U13 and U23, the processor/power fail circuitry, when the +5V supply is below its lower limit.

Processor/Power Fail Circuitry — This circuitry sounds the piezo speaker if the processor fails to operate or the 5V power unexpectedly falls below its lower regulation limit.

e. Connectors

This section describes UIF connectors and pinouts other than the docking connector J13.

J8 — J8 is a 40-pin daughter board connector that interfaces the UIF module to the communications board. This board uses only the first 16 pins on the connector.

Table S4-2: J8 Connector

Pin No.	Pin Description	Input/Output/Power
1	Ground	Power
2	Ground	Power
3	UARTTXD (RS232/422 only)	O
4	Ground	Power
5	UARTRXD (RS232/422 only)	I
6	Internal Stackbus	I/O
7	QData (sub module detection)	I
8	UARTDTR (RS232/422 only)	O
9	Ground	Power
10	VCC	Power
11	VCC	Power
12	VCC	Power
13	VCC	Power
14	Ground	Power
15	External Communications Standby	O
16	UARTDSR (RS232/422 only)	I
17	Not Used	n/a

Table S4-2: J8 Connector - (Continued)

Pin No.	Pin Description	Input/Output/Power
18	NURSECALL	O
19	Not Used	n/a
20	Ground	Power
21	Interrupt from second COM20020	I
22	Analog power	Power
23	Ground	Power
24	Ground	Power
25	Reset	O
26	DSL (data strobe low)	O
27	SDCK (used for sub module detection)	I
28	Chip select	O
29	Read/Write Strobe	O
30	D14	I/O
31	D12	I/O
32	D15	I/O
33	A1	O
34	D13	I/O
35	A2	O
36	D10	I/O
37	D8	I/O
38	D11	I/O
39	A0	O
40	D9	I/O

J12, J22 — These are two identical connectors that interface to the SpO_2 module. Power and stackbus signals are sent to these modules. Additionally, a connection between these two connectors allows the modules to communicate without stackbus, if necessary.

Table S4-3: J12, J22 Inter Module Connector

Pin No.	Pin Description	Input/Output/Power
1	Ground	Power
2	VDD	Power
3	Internal stackbus	I/O
4	VDD	I/O
5	Signal line from expansion module to SpO_2	I/O
6	VDD	I/O
7	Signal line from SpO_2 to expansion module	I/O
8	Module reset	I/O
9	High voltage power	Power
10	Ground	Power
11	Not used	n/a
12	Ground	Power
13	Not used	n/a
14	Ground	Power

J5 — Connector J5 connects to the display board, which allows the UIF module to control the monitor display. Signals at this connector include power, serial clock and data lines, button signal, and charging battery indicator current.

Table S4-4: J5 Display Connector

Pin No.	Pin Description	Input/Output/Power
1	Power (from switch–controlled by external watchdog)	Power
2	Power (from switchÐcontrolled by external watchdog)	Power
3	Power for green Power On LED	Power
4	Serial clock	O
5	LED drivers latch enable	O
6	Data out	O
7	Power to Battery Charging LED	Power
8	Not used	n/a
9	On button	I
10	Button voltage	I
11	Not used	n/a
12	Charge bus voltage	Power
13	Digital ground	Power
14	Digital ground	Power

J2 — Connector J2 connects the UIF board to the monitor speaker.

Table S4-5: J2 Speaker Connector

Pin No.	Pin Description	Input/Output/Power
1	Differential speaker signal +	I/O
2	Differential speaker signal –	I/O

J3 — Knob connector J3 allows the U3 controller to detect knob movement.

Table S4-6: J3 Knob Connector

Pin No.	Pin Description	Input/Output/Power
1	Digital ground	Power
2	Knob channel B	I
3	VDD	Power
4	Knob channel A	I
5	Chassis (case) ground	Power

S4.2.4 SpO_2 Controller

The central processing unit (CPU) for the SpO_2 Controller PCB is the U1 microprocessor. It contains an 8-channel, 10-bit analog-to-digital converter. Six inputs—ANALOG0 to ANALOG5—are bussed to the analog board interface connector, J4. Of the remaining signals, ANALOG6 is connected to Vcc and ANALOG7 is connected to ground. These analog inputs are used during the POST to verify proper operation.

a. CPU Reset

Voltage monitor U2, shown in the upper left-hand corner of the schematic diagram, generates the reset for U1. Reset is held low until Vcc raises above 4.6 volts. After Vcc is above 4.6 volts, reset is tri-stated and pulled high by R10. Note: L1, L2, and L3 provide filtering for Vcc.

b. Program Memory (EPROM)

The program memory chip, U4, provides the SpO_2 controller board with 128K bytes of memory. This program boot ROM memory can be expanded up to 256K bytes. The CSBOOT signal from U1, which is configured for 16-bit memory access, provides the enable signal for U4. After system software comes on, or is booted up, CSBOOT is configured for a start address of 0, a block length of 256K bytes, both read and write access, and gated with AS. This configuration provides a program memory range of 00000h through 3FFFFh.

The number of wait states needed before the CSBOOT signal is generated depends upon the U1 clock speed and the speed at which U4 can successfully perform its functions. With the N-3000, the number of wait states must be set to 1, based upon a CPU clock speed of 16.0 MHz, maximum, and the U4 access time of 150ns, maximum.

Resistor R22 pulls the U4 OE signal state to low during normal operation. If this signal state is high, the U4 output is disabled.

c. RAM Memory

The U5 RAM chip provides the SpO_2 Controller board with 128K bytes of memory. The U1 CS0 provides the chip enable signal for U3.

The U3 hardware has an 8-bit wide data path. After boot up, CS0 is configured as a chip select with a start address of 40000h, block length of 128K, 8-bit port, both bytes access, both read and write access, and gated with AS. This configuration gives a data memory range of 40000 through 5FFFFh.

The number of wait states to generate depends upon the U1 clock speed and the U3 access speed. The number of wait states for CS0 is set to 0, based on a U3 access time of 85ns, minimum.

d. Stackbus

The SpO_2 controller board also communicates with other boards within the N-3000 via the stackbus. The stackbus is controlled by the COM 20020 Arcnet controller chip, U6, which is enabled by U1 CS1.

CS1 must be configured as a chip select with a start address of 60000h, block length of 2k, 8-bit port, both bytes access, both read and write access, and gated with AS. This configuration maps the stackbus in the memory range of 60000h through 607FFh.

The number of wait states to generate depends on the U1 clock speed. The number of wait states for CS1 must be set to 2, based upon a CPU clock speed of 16.0 MHz.

e. Programmable Clock

The clock frequency on the SpO_2 controller board is programmed via software. The clock signal is labeled CTRL_CLK. The clock circuitry consists of U7 and U10. One half of U7 takes a 20 MHz input and produces three output frequencies: 10 MHz, 2.5 MHz, and 1.25 MHz. The 10 MHz frequency is the clock rate of the programmable down counter, U10. The second half of U7 takes the terminal count (TC) output of U10 and converts it to a 50% duty cycle square wave.

The frequency of CTRL_CLK is controlled by an 8-bit number. The bits of this number are split between two output ports. The lower 5 bits of the number are programmed on the lower 5 bits of port C. The upper 3 bits of the number are programmed on the upper 3 bits of port E.

The formula for the CTRL_CLK frequency is: frequency = 5MHz/ (1 + TIME), where TIME is the 8-bit number output by the CPU. TIME has a valid range of 1-255. The circuit provides an adjustment range of 19.531 kHz to 2.5 MHz.

The CTRL_CLK signal is input back to U1 Pin 16. During the POST routine, this pin is used to monitor the programmable clock hardware output to verify performance.

f. Intermodule Connector

The SpO_2 controller board is connected to the UIF board via the J1 intermodule connector. The UIF board provides power to the SpO_2 controller. Stackbus and module synchronization lines are also routed through J1.

S4.2.5 ECG Controller

The ECG Controller processes and controls the ECG lead inputs to the N-3000 through the ECG PCB. The central processing unit (CPU) for the ECG Controller PCB is microprocessor U1.

a. CPU Reset

Voltage monitor U2, shown in the upper left-hand corner of the schematic diagram, generates the reset for U1 and other circuits on the PCB. Reset is held low until Vcc raises above 4.6 volts. After Vdd is above 4.6 volts, reset is tri-stated and pulled high by R10. Note: L1, L2, and L3 provide filtering for Vdd.

b. Program Memory (EPROM)

The program memory chip, U4, provides the ECG controller board with 128K bytes of memory. This program boot ROM memory can be expanded up to 256K bytes. The CSBOOT signal from U1, which is configured for 16-bit memory access, provides the enable signal for U4 on the ROMEN-L line. After system software comes on, or is booted up, CSBOOT is configured for a start address of 0, a block length of 256K bytes, both read and write access, and is gated with AS. This configuration provides a program memory range of 00000h through 3FFFFh.

The number of wait states needed before the CSBOOT signal is generated depends upon the U1 clock speed and the speed at which U4 can successfully perform its functions. With the N-3000, the number of wait states must be set to 1, based upon a CPU clock speed of 16.0 MHz, maximum, and the U4 access time of 150ns, maximum.

Resistor R22 pulls the U4 OE signal state to low during normal operation. If this signal state is high, the U4 output is disabled.

c. RAM Memory

RAM chips U5 and U8 provide the ECG Controller board with 256K bytes of memory.

The 16 bit RAM data bus is split into a high byte and a low byte for RAM chips U5 and U8 respectively. High byte RAM U5 is output enabled when the R/W-L lines from U1 is set high and the HRAMEN-L line from U1 CS0 is set low. Low byte RAM U8 is output enabled when the R/W-L line from U1 is set high and the LRAMEN-L line from U1 CS2 is set low. Both RAM chips are write enabled when the R/W-L line from U1 is set low.

d. Stackbus

The SpO_2 controller board also communicates with other boards within the N-3000 via the stackbus. The stackbus is controlled by the COM 20020 Arcnet controller chip, U6, which is enabled by U1 CS1.

CS1 must be configured as a chip select with a start address of 60000h, block length of 2k, 8-bit port, both bytes access, both read and write access, and gated with AS. This configuration maps the stackbus in the memory range of 60000h through 607FFh.

The number of wait states to generate depends on the U1 clock speed. The number of wait states for CS1 must be set to 2, based upon a CPU clock speed of 16.0 MHz.

e. Analog Interface

The ANALOG0 to ANALOG5 signal lines are used as the analog interface with the ECG PCB through connector, J4. These analog signal lines are applied to analog-to-digital converter U10. Digital representations of the analog signals are then provided to microprocessor U1 serially on the MISO/QS0 line.

f. Intermodule Connector

The ECG controller board is connected to the UIF board via the J1 intermodule connector. The UIF board provides power to the ECG controller. Stackbus and module synchronization lines are also routed through J1.

S4.2.6 Communications Submodule

The communications submodule contains circuitry for allowing 1500V isolated asynchronous serial RS232 or RS422 communications between the N-3000 UIF module and a host computer, a 1500V isolated nurse call signal that operates whenever an alarm condition exists, or a 1500V isolated 3.3V power source for powering remote external serial equipment.

Signals that originate on the UIF board include:

UARTTXD	Transmit data from UART
UARTRXD	Receive data to UART
UARTDTR	Data terminal ready from UART
UARTDSR	Data set ready to UART

ALARMACTIVE	Prog. I/O from UART
Shutdown	Prog. I/O from UART

Connector J5 contains the signals for communicating with the UIF board (J8), as detailed in Table S4-2.

Auxiliary connector J2 on the communications PCB is for future expansion.

a. Serial Communications

Serial communications are available only when the SPS or PSS power supply is connected to the N-3000 docking connector and plugged into an AC outlet. When the UIF processor detects that CHARGEBUS is available, it enables isolation transformer driver U1 (MAX253). This creates power for circuitry on the isolated (host computer) side of the module. Transmit and Receive data cross the barrier through optical isolators U5 and U3 (6N136). CTS and RTS signals cross the barrier through optical isolators U4 and U2 (4N26).

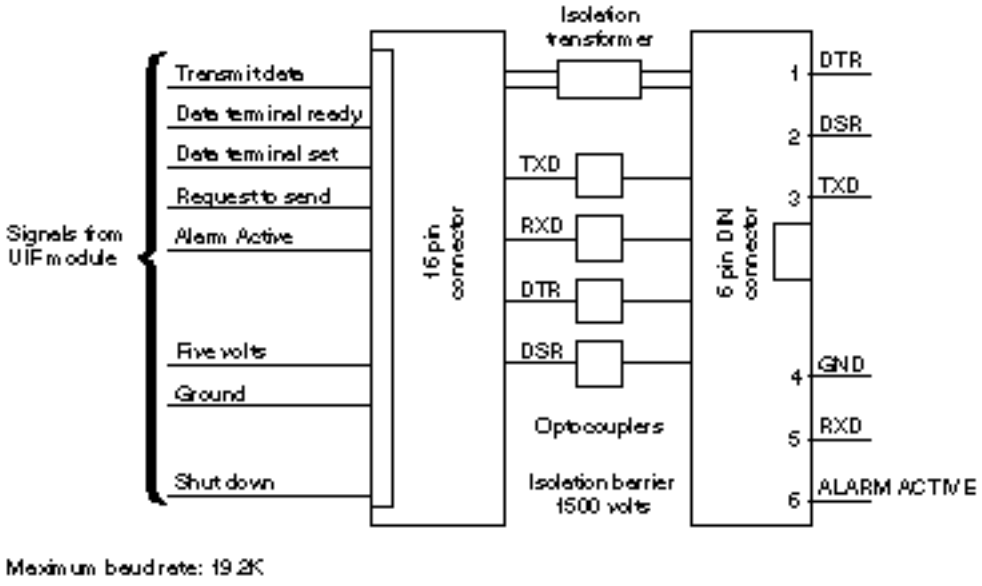


Figure S4-4: Communications Sub module Block Diagram

Selecting RS232 serial signaling is accomplished by moving switches S1,S3,S5,S7 on SW1 and SW2 to the on position and switches S2,S4,S6,S8 to the OFF position. This enables U9 and disables U10. With RS232 selected, J1 has the following pinout:

1 DTR
2 DSR
3 TXD
4 GND
5 RXD
6 Nurse Call/3.3V

Selecting RS422 serial signaling is accomplished by moving switches S2,S4,S6,S8 on SW1 and SW2 to the on position and switches S1,S3,S5,S7 to the OFF position. This enables U10 and disables U9. With RS422 selected, J1 has the following pinout:

1 TXD-
2 RXD-
3 TXD
4 GND
5 RXD
6 Nurse Call/3.3V

b. Alarm Active/3.3V Power

Isolated alarm active or 3.3 volt power is selectable as a 500mA fused output on J1 Pin 6. Placing switch block SW3, S1 to the on position, and S2,S3,S4 to the OFF position, will select the alarm active signal on J1, Pin 6. The alarm active signal provided is a normally open relay that shorts Pin 6, J1 to Pin 4, J1 signaling an alarm event.

To select isolated 3.3 volt power, place switch SW3 S1 to the OFF position and S2,S3,S4 to the on position. This provides up to 100mA of 3.3 volt power.

S4.2.7 Display Board

The N-3000 display board is the assembly that contains the front-panel display for the monitor. The display board is connected to and controlled by the UIF module. The display board block diagram is shown in Figure S4-5.

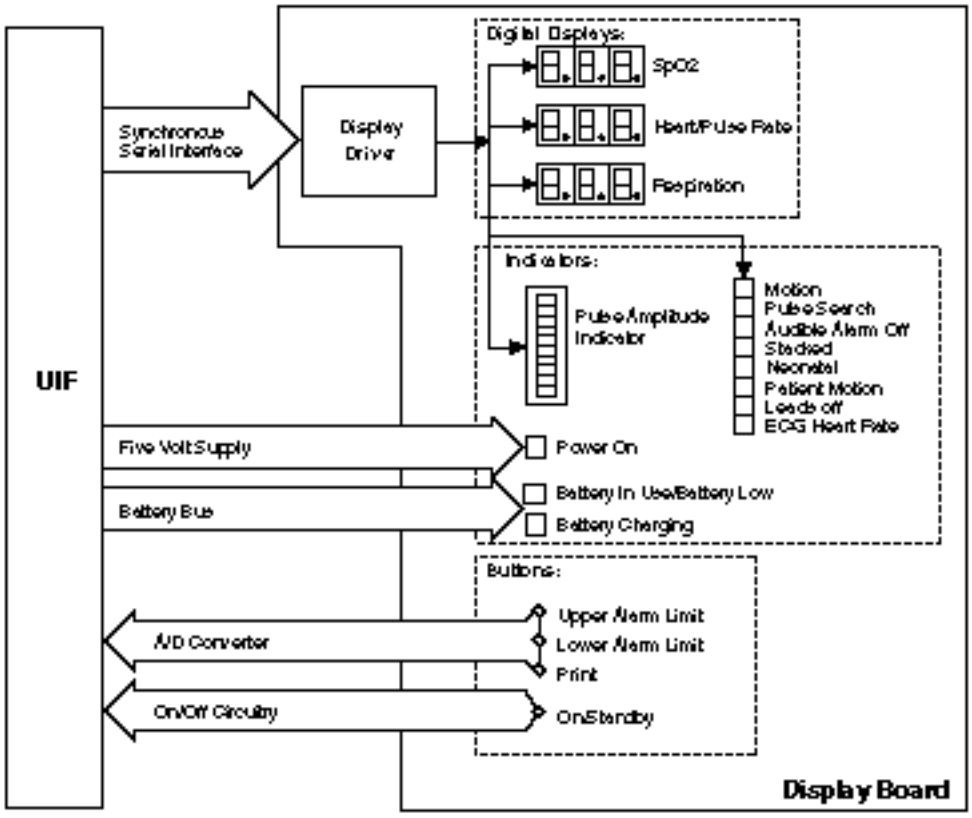


Figure S4-5: Display Board Block Diagram

The display driver ICs consist of U1, U2, and U3, which use a three-wire serial interface connect to CPU U3 on the UIF module. The three drivers used on this module are cascaded together and require that the host processor write 48 bits (16 x 3) to the board per each display update.

The front-panel POWER LED (DS23) is lit whenever the monitor power supply is on. The drivers do not provide power to light the BATTERY CHARGING indicator; current for this LED is provided by the UIF module.

There are four buttons on the display panel: the ON/STANDBY button (SW2) is connected directly to the UIF module. The other three—UPPER ALARM LIMIT (SW1), LOWER ALARM LIMIT (SW3), and PRINT (SW4)—are resistor-weighted and attached via one signal line to an A/D channel of the UIF module. U4 is employed as a drain device to guarantee a certain resistance value when a button is pressed.

The J1 connector pinouts are as follows:

1	+5V power for display drivers	8	NC
2	+5V power for display drivers	9	ON button signal, ONBUTTON
3	+5V power for green LED, GREENPWR	10	Button signal, BUTRES
4	Serial clock to display drivers, SERCLK	11	NC
5	Load data to display drivers, LED1EN	12	NC
6	Serial data to display drivers, SERDATA	13	Ground
7	Current source to battery charging indicator, CHRGPWR	14	Ground

S.5 SCHEMATIC DIAGRAMS

The following part locator diagrams and schematics are included in this section:

Figure	Description
Figure S5-1	SpO_2 PCB Part Locator Diagram
Figure S5-2	ECG PCB Part Locator Diagram
Figure S5-3	UIF PCB Part Locator Diagram
Figure S5-4	SpO_2 Controller PCB Part Locator Diagram
Figure S5-5	ECG Controller PCB Part Locator Diagram
Figure S5-6	Communications PCB Part Locator Diagram
Figure S5-7	Display PCB Part Locator Diagram
Figure S5-8	SpO_2 Schematic Diagram
Figure S5-9	ECG Schematic Diagram
Figure S5-10	UIF Schematic Diagram
Figure S5-11	SpO_2 Controller Schematic Diagram
Figure S5-12	ECG Controller Schematic Diagram
Figure S5-13	Communications Schematic Diagram
Figure S5-14	Display Schematic Diagram
Figure S5-15	Lower Docking Connector Schematic Diagram